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An Assessment of the Greenland Halibut Stock Component in NAFO Division 1A Inshore

by

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Abstract

This paper presents the assessment of Greenland halibut in the inshore part of NAFO Division 1A. The area covers the fjords in the three distinctive geographical areas, Disko Bay, Uummannaq and Upernavik. Information from the commercial fishery (only landings, no effort information) and research survey (longline survey in Uummannaq and a gillnet survey in Disko Bay) was available for the assessment. The state of the stocks were as follows. **Disko Bay**: In the recent two decades annual landings increased from about 2 000 tons in 1987 to 10 500 tons in 1998 and 1999. Since then landings increased again from 2002 to 2003 reaching a record high of nearly 13 000 tons, and the following two years landings have been around 12 000 tons. Recruitment indices from Disko Bay and offshore areas suggest high 1997 and onward year-classes, which might benefit the fishery in these years. Both the gillnet and the longline surveys indicates abundant incoming year-classes. In the winter and summer fishery mean lengths has decreased for the past four years. The gillnet survey established in 2001 shows a slight increase in catch rates since 2002. The longline survey shows higher catch rates in 2001, 2004 and 2005 compared to the 1990s. **Uummannaq**: Catches have been increasing from less than 2 000 tons before 1987 to a record high of 8 425 tons in 1999, but have thereafter stabilized at about 5 000 tons in recent four years. Development in mean length in the summer fishery has showed an overall negative trend until 1999. Since then mean length in catches has increased slightly. In the winter fishery the mean length has been relatively stable except for the winter 2002, in 2005 both summer and winter mean lengths have been the lowest on record, and mean lengths from measurements February 2006 are at the same level as in 2005. Survey results from 1993 onwards indicated an increase in abundance until 1998. In 2001 and further in 2003 survey abundance index decreased significantly to the lowest observed, but the 2004 and 2005 indices are at about average of the time series. Catch composition in the commercial fishery has changed significantly since the 1980s towards a higher exploitation of younger age groups, but has stabilized in the recent decade. **Upernavik**: Landings increased from about 1 000 tons prior to 1992 to highest on record, 7 012 tons in 1998. Since then landings have decreased continually by more than 50% to 3 000 tons in 2003. In 2004 and 2005 landings were around 4 500 tons. Measurements from the commercial fishery are only available for the winter months 2005 and 2006 and no surveys have been carried out. Apart from total catches and some sampling from the winter fishery there is not enough information to evaluate present stock status. New fishing grounds in the northern part of the district (Kullorsuaq) are being exploited, mean individual weights from winter fishery in that location from 2002 to 2006 show a declining trend.

Introduction

The Greenland halibut stock component in Div. 1A inshore is considered to be recruited from the Davis Strait stock, but the adults appear resident in the fjords and are thus isolated from its origin spawning stock (Riget and Boje,

1989). As a result, the inshore component does probably not contribute to the spawning stock in the Davis Strait (Boje, 1994). In samples from Disko Bay <10% of females in the reproductive age, were assigned mature during the assumed peak spawning period in spring (Simonsen and Gundersen 2005). Also in former times only sporadic spawning is observed in the inshore area (Jørgensen and Boje, 1994) and the inshore component is therefore not assumed to be self-sustainable, but dependent on recruits and immigration from the offshore area (Bech, 1995). Evidence that supported this stock structure resulted in 1994 NAFO to disconnect the assessment and advice on the inshore stock components from the offshore component in the Davis Strait and Baffin Bay.

Description of the Fishery and Nominal Catches

The lack of reliable landing data for recent years and incomplete data release from the Greenland authorities hampers the assessment of the inshore stock components in Div. 1 A. Official data on landings allocated on area (field-code), fishing gear and effort is a prerequisite for disaggregating catches and compiling catch in numbers, thereby allowing any analytical approaches to determine stock status. Improvement of the current assessment is entirely dependent upon this. In 2002, no information has been provided on gear types in the fishery. For a number of years, the catch statistics are preliminary and frequent changes to the database creates confusion on its reliability.

The main inshore fishing grounds for Greenland halibut in Greenland are in Div. 1A (Fig. 1), where the total landings amounted to 22 907 tons in 2005, and constitute far the majority (~99%) of inshore landings in Greenland. The inshore landings were around 7 000 tons in the late 1980's and increased until the late 1990s to a maximum of about 24 600 tons in 1998.

The inshore fishery in Div. 1A is located in three main areas: Disko Bay, Uummannaq and Upernavik (Fig. 1). The fishery is not quota regulated, but since 1998 regulations have restricted effort increase by means of licenses to conduct fishery. New license issues have since been limited after 1998 and the total number of licenses is actually around 1 300. There are no landing limitations on the fishery licenses. Therefore, in practice the effort is more or less unregulated.

The fishery is traditionally performed with longlines from small open boats or by dog sledges. In recent 10-15 years bigger vessels (>25 feet) have entered the fishery. Typically the fishery is carried out in the inner parts of the ice-fjords at depths between 500 to 800 m. In the middle of the 1980s gillnets were introduced to the inshore fishery, and were used more commonly in the following years. In the late nineties authorities introduced regulations limiting areas of gillnet fishery in order to limit effort. A total ban for gillnets has been in force since 2000. However, derogations have been given to this ban. Competence to lay down local rules have been given to Uummannaq and Upernavik municipalities in 2004, and areas where gillnet fishery is allowed has been expanded in all three municipalities. The gillnet fishery is regulated by a minimum mesh-size of 110 mm (half meshes), while there are no gear regulations on the longline fishery.

Disko Bay

Disko Bay is the area where Greenland halibut fishery developed in Greenland in the beginning of the 1900, and the major part of the catches in Greenland have traditionally been taken here. The landings in Disko Bay have increased continually until the late 1990s to about 10 500 tons (Fig. 2 and Table 1). After a decline in 2001 to 7 052 tons, landings have increased again in 2002 and further in 2004 to a historic high of 12 857 tons, in 2005 landings amounted 12 451 tons. The Greenland halibut fishery is conducted in, and in front of an ice fjord (Kangia) in the immediate vicinity of Ilulissat town, and in an icefjord north of Ilulissat, Torssukattak (Fig. 1). The winter fishery in Ilulissat Icefjord, Kangia, is a traditional fishery from the ice using longlines. The fishery near Ilulissat is conducted within a small area (2 nm^2) and consist of a mixture of gillnet and longline fishery. However, the gillnet fishery is restricted to areas further from the icefjord than the longline fishery. The majority of the landings in Disko Bay are caught within this area. The fishery in Ilulissat and the other two areas is carried out in all seasons but most often peak in summer (Fig. 3). It has been observed that the fish disappear from the area in mid July, where after the fishery move to Torssukattak north of Ilulissat (Simonsen and Roepstorff, 2000). The fishery in Torssukattak is almost exclusively carried out in the period July - August. Fishery in this fjord is restricted by sea ice in spring.

Uummannaq

The landings in Uummannaq were stable around 3 000 tons prior to 1992, but has increased with some fluctuations until 1999 where 8 425 tons were landed. After a decline to 5 039 tons in 2003, landings again increased to 5 248 tons in 2004 and decreased in 2005 to 4 856 tons (Fig. 2 and Table 1).

The fishery in Uummannaq area is conducted in a large system of icefjords. The main fishing grounds are in the southwest part of the fjord system. In previous times the southernmost icefjord, Qarajaqs Icefjord was the main fishing area but during the last decade the fishery has spread further north to include Sermilik and Itiviup Icefjords (Fig. 1). Use of gillnets is developing and in 2005 catches by gillnet exceeded that of longlines, use of gillnets is prohibited in the inner parts of the fjords in Uummannaq.

Upernavik

The northernmost area consists of a large number of ice fjords. Fishery in this are started in the 1980s. The main fishing grounds are Upernavik Ice fjord and Giesecke Ice fjord. New fishing grounds around Kullorsuaq in the northern part of the area are exploited these years (Fig. 1). Use of gillnets have been prohibited in Upernavik but derogations have been given for a fishery outside the Icefjords since 2002.

The landings in the Upernavik area have increased steadily from about 1 000 tons in the late 1980s to about 3 to 4 000 tons in 1993 to 1995 (Fig. 2 and Table 1). The total landings in 1998 were the highest on record 7 012 tons. Since then landings declined to 3 019 tons in 2002 followed by a steady increase up until 2005 where landings were 4 839 tons.

3. Input data

3.1. Research Surveys

Longline survey

Prior to 1993 various longline exploratory surveys were conducted with research vessels. Due to variable survey design and gear, these surveys are not comparable. In 1993 a longline survey for Greenland halibut was initiated for the inshore areas of Disko Bay, Uummannaq and Upernavik. The survey was conducted annually covering two of three areas alternately, with approximately 30 fixed stations in each area (for further details see Simonsen *et al*. 2000). This survey has recently been evaluated and the main conclusions drawn are that the survey does not generate sufficient data for proper statistical analyses; this in combination with an almost unknown selectivity of the gear as well as catch efficiency, prevents to use survey results as anything than indicative of overall stock trends, e.g. no information on year-class strength and population in absolute numbers. Therefore, a pilot study on using gillnet (multi-meshed) as survey gear have been performed since 2001. Parallel with the new gillnet survey the aim was to continue the longline survey. However in 2002 no longline survey was conducted and in 2003 the longline survey was only conducted in Uummannaq. Due to varying coverage and number of longline settings between years, survey CPUEs have been standardised with respect to depth and area effects by use of a GLM.

Gillnet survey

The main objective for using gillnets is a well-estimated selectivity and the possibility for targeting pre-fishery sized Greenland halibut, i.e. lesser than 50 cm. The survey has been conducted since 2001 with the research vessel 'Adolf Jensen' in Disko Bay. The location is chosen due to the known presence of pre-fishery recruits in combination with a bottom topography (approx. 3-400 m depth of even clay ground) that allows fishing with gillnets. The northern areas, Uummannaq and Upernavik, have both tough rock grounds not suitable for gillnet fishing. Only 8 stations were fished in the first survey year 2001, thereafter the number increased to about 50-60 (see Table 2). The surveyed area covers the proposed young fish areas in Disko Bay, off Ilulissat and the Icefjord and off the northern icefjord Torssukattak (Fig. 4). Mesh sizes 45, 52, 60 and 70 mm (knot to knot) with twines 0.28, 0.40, 0.40 and 0.50 mm correspondingly, were used to target the fish size groups approximately 30-50 cm. Multi-gang gillnets being approx. 300 m were composed of 4 sections, one of each mesh size, with 2 m space between each section to prevent

catchability interactions between sections. Soaktime is approx. 10 hours and fishing occurred both day and night. Stations were paired two and two, close to each other to allow for analysis of within station variability. The survey uses fixed positions of stations.

The gillnets are selecting Greenland halibut in the length range 30-50 cm. Greenland halibut larger than 50 cm are abundant in the area, but seem mostly concentrated at the commercial fishing grounds in the immediate vicinity of Ilulissat and in the Icefjords, Kangia (Ilulissat Icefjord) and Torsukattak in the north. The gillnet survey do not cover those commercial fishing grounds. Greenland halibut smaller than 30 cm are occasional abundant in the area, but are mostly recruited from offshore areas off Disko Bay and are supposed to perform a stepwise migration towards the commercial fishing grounds near the icefjords.

Recruitment indices.

Greenland Institute of Natural Resources conducts annual surveys with R/V "Pamiut" in 3rd quarter for shrimp and demersal fish as described in Sünksen and Jørgensen (SCR Doc. 06/28). And since 1992 it has been extended to include the Disko Bay, fish have been routinely measured, and Greenland halibut are disaggregated to ages 1-3 by the Petersen method. In 2005, 16 hauls were conducted in the Disko Bay. The CPUE for Greenland halibut (number per age per hour of ages 1-3) is estimated for the Disko Bay, using tows from depths >300 m. The index is assumed indicative for recruitment to the Disko Bay fishable stocks only. Recruitment dynamics for the northern areas, Uummannaq and Upernavik are unknown.

3.2. Commercial fishery data

Landings data

Data on the inshore landings of Greenland halibut for Disko Bay and Uummannaq in 2005 were obtained from Royal Greenland (RG) for the cities of Ilulissat, Qasigiannguit and Uummannaq, and Greenland Statistics (GS). Data from Upernavik was obtained from Upernavik Seafood A/S. Only a part of the data from 2005 was allocated to gear, and the remaining catches were allocated according to these available data. Summer was defined as June-November (both included), remaining months were classified as winter.

Processed fish is normally converted to whole fish weight using a conversion factor set by the authorities. The conversion factor for gutted fish with head and tail are multiplied by a factor 1.10. The conversion factor for gutted fish without head and tail are 1.35.

In order to obtain length distributions for the commercial catches/landings random samplings from gillnet and longline fishery are carried out annually in the three main areas in February/March and July/August. Sampling intensity from the commercial fishery in the recent year is given in text table below.

Sampling	**2005**	**Disko Bay**			
Nos length measurements					**Nos otoliths**
Gear \Season	Summer	Winter	All	% sampled	
Longline	**3636**	**1926**	5.562		
Gillnet		**3740**	3.740		
All	3.636	5.666	9.302	0,236	836

Sampling	**2005**	**Uummannaq**			
Nos length measurements					**Nos otoliths**
Gear \Season	Summer	Winter	All	% sampled	
Longline	**3666**	**745**	4.411		
Gillnet	**1424**	**95**	1.519		
All	5.090	840	5.930	0,532	609

Effort

Logbooks are not mandatory in the entire inshore fishery. However, a regulation has recently been put in force on mandatory logbooks for vessels longer than 30 feet.

Catch-at-age

Catch-at-age data were compiled for the 2005 fishery, based on otolith sampling in summer, both from the surveys and from the commercial fishery (Table 5). For 2005 the ALK for Disko Bay was based on otoliths from Disko Bay in 2003-2005, due to incomplete coverage in 2005. For Uummannaq in 2005 an ALK, with 2003 and 2004 readings, from Uummannaq was used (Table 6). With the exception on otoliths from 2005, otoliths from the inshore part of Div. 1A have been read by the same otolith reader from GINR in the entire period. No reliable maturity data were available. For 2005 the gillnet fishery in summer was not sampled. Catch composition from this fishery was assumed equal to the winter gillnet fishery.

4. Assessment

4.1. Gillnet survey

The gillnet survey uses 4 different mesh sizes, 46, 55, 60 and 70 mm, for which is assumed a bi-modal selection curve as shown in Fig. 5. Gillnet selection curves are well-known being skew and not only characterized by a normal distribution. In order to account for catch of larger fish a bi-modal approach was chosen. The mesh sizes 46, 55, 60 and 70 mm was chosen in order to select fish in the length range 30-50 cm, i.e. pre-fishery recruits. From the selection curves in Fig 5, it is obvious that selection is nearly 100% in that length interval, thus it is assumed that the catches in this length range will reflect the fished population.

Most catches in the survey was obtained in the area just north of Ilulissat (stat. sq. LH028) and off the northern Icefjord Torssukattak (Fig. 6). Figure 7 give standardised catch rates in survey from 2001 to 2005; from 2001 to 2002 both CPUE and numbers per unit effort (NPUE) decreased, and have since continuously increased to catch rates as obtained in 2001. The catches have been expressed as catch in kg or numbers per 6 hours of setting, assuming that catch rates are linear positive related to soak time. This has, however, not been proved, and since soak time is on average twice as high in 2002 as compared to 2001 and 2003, the trend in catch rates between years is dependant on this assumption. Dis-aggregating the CPUE and NPUE by length groups, show that the number of small fish increased in 2004 compared to previous years but decreased in 2005 though still remaining at a level above average of the time series.

Assuming a bi-modal selection curve (Wilemans wings) as given in Fig. 5 will result in relative underlying populations as provided in Fig. 8b. The fit of the assumed selection curve to the catch data is given in Fig. 8a. The estimated relative population suggest an inflow of small fish since 2003, but cohorts are not easy to follow. Age distributions are rather uniform between years and only in 2003 high abundance of age 3 deviate from the mean (Fig. 9).

4.2. Longline survey

Since 2001 when the gillnet survey was initiated, the longline survey has been restricted and the aim is to cover the areas Uummannaq and Upernavik only by longline survey. In order to establish a calibration key between the gillnet and longline surveys, longline settings were conducted in Disko Bay in 2004 and 2005. This allow an extension of the newly initiated gillnet survey index back in time (SCR Doc. 05/57).

Survey CPUE

Disko Bay

Apart from 2001 a longline survey was carried out in 2004-5 (Fig. 11). CPUE in 2004 and 2005 were similar high and above the average catch rate, at about same level as in 2001. Thus since 2001 catch rates are considerably higher than those obtained in the period 1993-2000 although not statistically significant. Length distributions of catches have since 2001 been narrower than prior to 2001 (Fig. 10 and 12). The ratio between landings and survey catch

rates as a proxy for exploitations rate suggest a lower exploitation in recent 6 years (Fig. 13).

Uummannaq

In Uummannaq mean size have been very stable in the time series of the longline survey. Mean length increased from 57 cm to 62 cm in 1998 and has since decreased to 56 cm in 2005 (Fig. 10, Table 4). Catch rates have, however, showed a considerable decrease from 1998/99 to 2003, but has since increased in 2004 and 2005 to about average of the time series. (Fig. 11). The length composition in the survey catches have varied considerably since 1993, in general being broad (Fig. 11). Distributions suggest that good year-classes are contributing to survey since 2003. Using the relation between total catches and the survey index as an approximation for exploitation level, reveal that exploitation of the populations in Uummannaq have increased since the late 1990s and especially in 2003. However both in 2004 and 2005 the index is low (Fig. 13).

Upernavik

Since 2000 no longline survey has been carried out in Upernavik.

4.3. Exploratory analytical assessments

Exploratory assessments were conducted for the Disko Bay area based on catch at age data 1988-2005, the GINR Gillnet survey 2001-2005 and the Pamiut trawl survey 1988-2005. Due to the resident behaviour of Greenland halibut in the Disko Bay (Boje, 1994), the population is considered a well-defined biological entity with recruitment from the offshore areas. The outcome of the exercise is only considered exploratory since the assessment varies considerably depending on which index is included in the model and as also strong retrospective patterns are found. Further, age readings are considered of relatively noisy for especially the older ages.

Input

Due to incomplete age samplings since 2001, an annual ALK that combines ALK for the preceding years (i.e. 2001 for 2001, 2001+2002 for 2002, 2001+2002+2003 for 2003) were used in the catch at age estimation. Catch-at-age is available back to 1988 (Table 5) and samples have been conducted both by season and by gear (summer-winter, gillnet-longline). Catch curves (Fig. 14) and the mean standardized CN (Fig. 15) suggest that most age groups have become more abundant in catches, but also that the matrix is rather noisy and inconsistent between years.

For the age compilation of the Gillnet survey index was used same ALK procedure s for the catch-at-age. The Pamiut Disko Bay trawl survey index of Greenland halibut ages 1-2 was age disaggregated by means of the Petersen method as described in Jørgensen and Sünksen (SCR Doc. 06/28).

Mean weight at age in the stock was considered equal to weight at age in the catch (Fig. 16). From 1988 to 1992 few samplings were taken and weight at age is averaged in that period. Since 1998 no trends are visible for the mean wgt-at-age, however, compared to previous periods, older fish have decreased in mean weight.

No maturity at age data were presently available so a knife-edge ogive was used assuming age 10+ fully mature.

A matrix plot tracking year-classes from one year to the next shows that the gillnet survey has a poor internal consistency compared to that of the Paamiut survey (Fig. 17). The longer time series of the Pamiut survey at ages 1 and 2 with a determination coefficient of less than 0.3 doesn't show a better internal consistency (Fig. 18).

Separable VPA

A Separable VPA was performed in order to explore the internal consistency in the catch at age matrix. The options suggested by an XSA run, were Terminal F of 0.200 on age 11 and Terminal S of 1.000 (Table 7). Large negative residuals are seen for younger age groups and mainly positive residuals are seen for the older age groups (Fig. 19). No trend in residuals is evident over time.

XSA

The gillnet survey (2001-2005) and the Pamiut trawl survey in Disko Bay (1988-2005) was used to estimate terminal F's (tuning fleet). Since the gillnet survey is designed to select length 30-50 cm, only indices for ages 2 to 6 was used from the survey (Table 8). The Pamiut trawl survey in Disko Bay is targeting recruits and ages 1-2 were used from that survey. Data are available for age 1+2 from 1991-2005. Catch curves from the Pamiut trawl survey (Fig. 20) shows that high year-classes after the mid-1990s are recorded consistently by the survey and that total mortality seem unchanged since then. In the gillnet survey ages that is supposed to be fully selected to the survey (i.e. ages 2-6) do not seem to be fully selected and catch curves cannot be assessed with regard to mortality rates.

Given the inconsistency between ages and the short time series (5 years) in the gillnet survey, a run with the following parameters is given as illustrative and should be treated with caution.

Diagnostics from an XSA run with a catchability independent of stock size, shrinkage = 0.5 (Fig. 21) showed that survey indices are weighted most for the younger ages. Log q residuals range between –1.5 and 2.5, age 2 from the gillnet survey being the most deviant, most of the residuals range between –1.0 and 1.0 and show no trend over time.

A survey based assessment approach (SURBA) was also explored. SURBA uses abundance indices (from research-vessel surveys or elsewhere) to generate relative estimates of abundance and absolute estimates of mortality. It is based on a separable model of mortality ($Z(a,y) = s(a)*f(y)$) and uses weighted least-squared nonlinear regression to estimate values of s, f and cohort strength r that minimize the sum-of-squares between observed and modeled indices. The input data may be age-structured or biomass indices. Externally-defined estimates of survey catchability are required, as is a time-series smoother to reduce the excessive influence of noisy data. The method is coded in Fortran-90 and includes an intuitive, Windows-based graphical user interface. SURBA is used widely in ICES assessment working groups, where it is employed in mostly exploratory data analysis (Needle, 2003).

The gillnet survey only covers 5 years (Fig. 22) and consequently SURBA results based on this survey only provides very uncertain estimates. Using the Pamiut survey (ages 1-3+, Fig. 22) performed better, but do only cover the juvenile fish in the stock (Fig. 23). Total mortality seems to increase slightly. Including both surveys did not improve the uncertainty in the stock estimates. Z shows no trend, TSB increase over the period and recent recruitment seem higher than prior to 2000.

In summary, the analytical exercises do not provide an accurate assessment of the Disko Bay stock, but suggest that the continuous increase in catches is due to increased recruitment in combination with an increased fishing mortality. However, the assessment is unable to estimate the relative size of these two elements.

4.4 Commercial Fishery

Size distribution

Mean lengths from the longline landings in the period 1993 to winter 2005 in Disko Bay and Uummannaq are showed in Fig. 24. In Upernavik no sampling have been conducted from the commercial fishery from 2002 until winter 2005. Fish caught in summer are generally smaller than fish caught during winter.

In Disko Bay mean length in the winter fisheries have fluctuated considerably during time, with a slight increasing overall trend. The variation could be due to inadequate sampling. Mean length in the winter fishery decreased from a high of about 80 cm in 2001 to 64 cm in 2005. Fishing at the traditional winter fishing grounds in the icefjord has been impeded in the recent years due to lack of land-fast sea-ice (the fishery is traditionally conducted from the sea-ice) and an open-water fishery developed on alternative fishing grounds. This change in fishing grounds may have affected mean size in landings. Mean lengths in the summer fishery have fluctuated between 1993 and 2001 with a slightly increasing trend, but have thereafter been decreasing from 63 cm in 2001 to 57 cm in 2005.

In Uummannaq mean lengths in the winter fishery have been stable throughout the period at about 66 cm. Mean size in landings from the summer fishery decreased in the early period from 1993 to 1997, but have thereafter remained stable at about 64 cm until 2005 where it dropped to 62 cm, mean size in landings from winter fishery have been

relatively stable around 66 cm until 2004 but have decreased in 2005 and 2006 to 63 cm.

Mean lengths in Upernavik winter fishery have been decreasing trough the 1990s, and have been stable around 62 cm since 1999 including the most recent samplings in 2005 and 2006. There have been no sampling from the summer fishery in the Upernavik area since 2002.

Individual weights Upernavik area

Since 2002 Upernavik Seafood has weighed each individual fish from the first landing of the day in Upernavik and Kullorsuaq. Mean individual weights from the winter fishery in Kullorsuaq have decreased from 6.7 kg in 2003 to 4.9 kg in 2006 (Fig. 25), though the fishery in Kullorsuaq, is limited to a small area (64 km^2) and the catches comprise around 15% of annual total catches in the Upernavik area.

Catch at age

For all three areas there have been a shift in exploitation pattern through the time series (Fig. 26). While the younger age groups comprised between 25% and 50% of the catches in the late 1980s and early 1990s, they now constitute about 60-80% of the catches. In Upernavik exploitation of the younger age groups have increased considerably in the period from less than 25% to more than 80% in 1999-2001. No catch-at-age is available for Upernavik since then.

Mean weight-at-age

Mean weight at age for Greenland halibut in the three fishing areas are shown in Fig. 27. The outliers in 1994 are considered to be due to errors in age readings. For the younger fish mean weight at age have varied in the sampled time series, but recent values are overall at same level as those in the beginning of the period. For the older fish (>age 12) there was a clear trend of a decline in mean weight at age in the period since 1993, but that has reversed from 2004 and 2005 while for ages 9 to 12 mean weights are stable.

Biomass and recruitment

Biomass and abundance indices in Disko Bay deeper than 300 m are higher in 1998-2005 than in 1992-1997 (Fig. 28.), the indices are based on the trawl survey where juveniles (1-3 year olds) comprise the main part of the catches, this biomass estimate is therefore more an estimate of recruitment than of total stock biomass.

Recruitment indices were available for Disko Bay (inshore). Since 1997 recruitment (age 1) have been considerably higher than in the former period (Fig. 20 and 29). Recruitment index of age 1 fish was high for the year-classes 1997, 1999, 2000 and 2003.

State of the Stock Components

The abrupt decline in landings in the most recent years which raised concern by NAFO in 2002, have reversed for all three areas since 2002. Exploitation of younger age groups has increased considerably for all areas in the past 10-15 years. The lack of information on fishing effort makes it difficult to evaluate trends in landings relative to stock biomass or fishing effort. As no surveys and only two samplings has been conducted in Upernavik area since 2001, there is no sufficient basis to evaluate the state of Greenland halibut stocks in that area in recent years.

Disko Bay

Since the beginning of the fishery for Greenland halibut in Greenland early in the 1900 in this area, landings have increased continuously. In the recent two decades annual landings increased from about 2 000 tons in 1987 to 10 500 tons in 1998 and 99. Since then landings declined to 7 000 tons in 2001, but increased again from 2002 to 2003 to a record high of more than 12 000 tons, and landings remained at around 12 000 tons in 2004 and 2005. The reason for this high variation is unknown, and no effort measures are available. Ice and weather conditions are known to influence use of gear type in the fishery and can also limit the total fishery. Favourable weather conditions (warmer) have

obviously endorsed the fishery in this period and consequently resulted in the high catches the last three years.

Recruitment indices from Disko Bay and offshore areas suggest high 1996 and onward year-classes. This could explain the increase in catches in recent years. High abundance of these year-classes is confirmed by the surveys.

In the commercial fishery mean length in catches are quite variable for the entire time series. In the winter and summer fishery mean lengths have however decreased in the past four years.

The gillnet survey shows a slight increase in catch rates from 2002 to 2005, however catch rates of smaller fish (<35 cm) have decreased in 2005 compared to 2004. The longline survey show high catch rates in 2001-2005 compared to the 1990s,

Uummannaq

Landings have been increasing from less than 2 000 tons before 1987 to a record high of 8 425 tons in 1999. Since then landings have declined and stayed around 5 000 tons in 2002-2005. The seasonal distribution of landings has been constant for the recent years.

Development in mean length in the summer fishery has showed an overall negative trend until 1999. Since then mean length in catches has increased slightly. In the winter fishery the mean length has been relatively stable except for the winter 2002, mean lengths from 2005 and winter 2006 are historically low. Age composition in catches from the commercial fishery has changed significantly since the 1980s towards a higher exploitation of younger age groups, but has fluctuated in the recent decade.

Survey results from 1993 to 1999 indicate an increase in abundance until 1999. In 2001 and further in the 2003 survey abundance index decreased significantly to the lowest observed. But the 2004 and 2005 survey index are around average for the time series. Mean lengths from the survey are relatively stable in the entire period and survey length compositions do not indicate any strong incoming year-classes

Upernavik

Fishery in Upernavik developed in the mid 1980s and thus constitutes the youngest inshore fishery in West Greenland. Landings increased from about 1 000 t prior to 1992 to about 5 000 tons in 1996 and 1997. In 1998 landings were the highest on record, 7 012 tons. Since then landings have decreased continually by more than 50% to 3 019 tons in 2002, though followed by an increase to 4 859 tons in 2005.

In 2002-2004 no samplings from the commercial fishery, but in 2005 and 2006 samples have been taken from the winter fishery, mean lengths from these samplings are not different from the mean lengths in the latest samplings in 2001. Individual weights from Kullorsuaq and Upernavik 2002 to 2006 are generally declining

General Comments

Beginning from May. 2006 vessels larger than 30 feet are obligated to use logbooks. A voluntary logbook was introduced in 1999 for parts of the inshore Greenland halibut fishery. However, the reporting rate has been to low to allow any analyses on the material.

An earlier study of the by-catch of Greenland halibut in the commercial shrimp fishery (Jørgensen and Carlsson, 1998) suggest that the by-catch is considerable and could have a negative effect on recruitment to the inshore stock component. However, sorting grids have since then been made mandatory in the shrimp fishery (since October 2000), but for the entire inshore shrimp fishery derogations have been given until recently.

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Table 1. Landings and Greenland halibut (tons) in Div. 1A distributed on the main fishing areas: Disko Bay, Uummannaq and Upernavik. Conversion factor 1.1 for gutted fish with head, 1.50 for gutted fish without head, 1.52 for gutted fish without head and tail fin.

	1987	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Disko Bay	2258	2670	2781	3821	5372	6577	5367	5201	7400	7837	8601	10671	10593	7574	7072	11718	11571	12857	12451
Uummannaq	2897	2920	2859	2779	3045	3067	3916	4004	7234	4579	6293	6912	8425	7568	6558	5339	5039	5248	4856
Upernavik	1634	777	1253	1245	1495	2156	3805	4844	3269	4846	4879	7012	5258	3764	3239	3019	3884	4573	4839
Unknown/other	407	636	599	507	17	133	0	0	0	0	0	0	55	2239				45	761
Total in Div. 1A inshore:	7196	7003	7492	8352	9929	11933	13088	14049	17903	17262	19773	24595	24332	21144	16869	20076	20494	22723	22907
STATLAN 21A	6696	6384	6927	7465	9243	11932	13204	14067	17046	17271	20835	19669	24333				21482	22947	
STACFIS	7196	7003	7492	8352	9929	11933	13088	14049	17037	17262	19774	24595	24332	21144	16869	20076	20494	22723	22907

Table 2. Number of gillnet settings by stat. square in gillnet survey in Disko Bay since 2001.

	Year				
Statistical square	2001	2002	2003	2004	2005
LA027				3	
LB027				1	
LD027			2		
LE027			2		
LF027			2	1	
LF028			2	1	
LG024			2	1	
LG026				3	
LG027	4	3	6	6	4
LG028	2	3	2	5	7
LH027		11	4	6	6
LH028	2	8	7	9	6
LH030		2		2	
LH038			1		
LJ026			2	1	
LJ028			4		
LJ030		5			6
LK024		2		1	
LK026		2		1	2
LK027		3		1	1
LK028		4			
LK029			4		
LK030		1			3
LK031		3			3
LL024				1	2
LL026		2		2	2
LL027		2		2	3
LL028				4	2
LL029			1		
LL031		1			
LM029			2		
LM030			2		
LM031			2		
LN024			2		
LN025			3		
LN026			2		
LN027			2		
LN028			2		
LP024		2			
Total	8	54	58	51	47

Table 3. Landings of Greenland halibut allocated on area, season and gear. Allocation on gear was obtained from 28.7% of Ilulissat, 30.5% of Uummannaq and 99.8% of Upernavik catches.

	summer longline	Gillnet	winter longline	gillnet	Total
Disko	6186	8	2214	4042	12451
Ummannaq	1727	1529	220	1379	4856
Upernavik	1922	926	1174	818	4839

Table 4. Mean length (cm) from catches taken in inshore longline surveys. Standardized survey since 1993

Area/year	1962	1985	1986	1987	1993	1994	1995	1996	1997	1998	1999	2000	2001	2003	2004	2005
Disko bay	-	62.4	53.5	62.2	55.9	56.5	-	53.6	57.0	-	56.7	54.3	56.1	-	51.0	50.8
Uummannaq	67.8	70.5	-	61.8	56.6	-	57.6	59.5	-	61.9	61.7		59.7	57.6	58.6	56.8
Upernavik	-	-	-	-	-	64.6	60.8	-	-	57.1		58.4				

Table 5. Catch at age of Greenland halibut. "–" indicates insufficient or missing sampling.

A) Disko Bay

	Catch in numbers (thousands)																	
age/ year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
4	0	0	0	5	34	7	0	0	0	0	0	1	0	1	0	0	0	1
5	0	0	0	5	92	15	3	0	8	0	0	4	9	15	2	2	2	48
6	1	0	0	11	122	62	15	0	1	21	74	41	98	33	54	64	56	287
7	9	0	1	279	332	280	112	45	47	132	397	360	535	224	283	425	409	516
8	59	14	24	806	476	479	281	459	323	646	775	619	729	390	561	722	691	703
9	182	106	141	535	390	339	539	639	941	1113	944	836	780	521	771	1.187	1083	868
10	173	121	185	333	451	280	396	798	651	1168	1248	1028	636	450	421	610	634	423
11	132	94	188	238	532	240	190	463	454	607	754	786	478	485	575	847	730	481
12	73	49	126	76	309	122	91	185	273	185	346	426	223	280	393	422	311	213
13	63	33	80	45	140	91	50	127	145	69	132	136	52	78	398	158	144	100
14	65	39	59	67	92	112	45	27	75	19	68	72	28	33	175	146	130	97
15	38	31	42	57	18	75	41	36	44	10	27	29	12	31	112	135	152	122
16+	33	41	44	44	0	86	36	27	69	6	6	2	1	16	0	89	89	83
Total	828	528	890	2501	2988	2188	1799	2806	3031	3976	4770	4340	3583	2557	3745	4808	4431	5769

B) Uummannaq

	Catch in numbers (thousands)																	
age/ year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
4	0	0	0	-	-	0	0	0	1	0	0	8	0	0	-	0	0	1
5	0	0	0	-	-	0	0	0	0	0	0	70	19	65	-	3	1	17
6	1	0	1	-	-	9	24	6	6	0	0	218	86	113	-	21	10	101
7	5	2	3	-	-	45	105	217	76	69	0	554	357	674	-	127	105	108
8	20	9	15	-	-	200	226	564	308	377	235	596	441	507	-	360	197	192
9	52	35	47	-	-	202	271	601	279	793	566	690	543	315	-	321	249	142
10	121	98	108	-	-	142	346	413	286	702	657	789	669	492	-	235	198	115
11	143	120	121	-	-	138	139	414	232	460	586	526	487	303	-	220	163	109
12	121	99	101	-	-	104	105	219	142	206	355	295	311	178	-	158	118	74
13	96	76	82	-	-	158	34	138	69	75	138	131	170	121	-	78	82	58
14	49	38	42	-	-	93	12	49	28	32	39	42	68	60	-	145	103	80
15	23	19	20	-	-	28	0	28	11	10	15	12	24	28	-	150	78	67
16+	17	20	21	-	-	20	3	22	15	6	5	4	8	12	-	94	59	50
Total	648	516	561	-	-	1139	1265	2671	1453	2732	2595	3935	3184	2868	-	1911	1364	1115

Table 6. Age-length keys used for 2005 catch in numbers.

	2003 +2004 + 2005 age readings Ilulissat + older fish (age 15+) from Uummannaq																	
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
25-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35-39	0	77	52	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40-44	0	14	92	32	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45-49	0	0	12	84	32	8	0	0	0	0	0	0	0	0	0	0	0	0	0
50-54	0	0	1	20	75	29	1	0	0	0	0	0	0	0	0	0	0	0	0
55-59	0	0	1	7	26	55	21	3	1	0	0	0	0	0	0	0	0	0	0
60-64	0	0	1	5	10	17	45	23	9	1	0	0	0	0	0	0	0	0	0
65-69	0	0	1	4	1	1	6	5	13	4	2	0	0	0	0	0	0	0	0
70-74	0	0	0	1	0	1	1	0	3	5	2	4	2	0	0	0	0	0	0
75-79	0	0	0	0	0	0	0	0	0	1	1	1	2	2	1	0	0	0	0
80-84	0	0	0	0	0	0	0	0	0	0	0	1	4	1	0	0	0	0	0
85-89	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0
90-94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
95-99	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
100-104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
105-109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110-114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

2003 + 2004 + 2005 age readings Uummanaq

winter	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**Sum**
30-34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
35-39	22	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
40-44	7	30	17	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
45-49	5	21	61	29	4	0	0	0	0	0	0	0	0	0	0	0	0	0	
50-54	1	13	9	46	23	0	0	0	0	0	0	0	0	0	0	0	0	0	
55-59	0	1	13	14	40	15	3	1	1	0	0	0	0	0	0	0	0	0	
60-64	0	2	11	10	9	33	18	7	2	0	0	0	0	0	0	0	0	0	
65-69	0	0	4	5	9	7	13	11	7	3	0	0	0	0	0	0	0	0	
70-74	0	0	3	0	5	1	0	3	3	3	4	2	0	0	0	0	0	0	
75-79	0	0	0	0	0	2	2	2	1	2	4	1	2	1	0	0	0	0	
80-84	0	0	0	1	0	0	0	0	0	0	1	4	2	0	0	0	0	0	
85-89	0	0	0	0	1	0	1	0	0	0	1	3	1	1	0	0	0	0	
90-94	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	
95-99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
100-104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
105-109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
110-114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	

Table 7. Separable VPA output

1

Title : Greenland halibut 1A Disko bay

At 7/06/2006 16:01

Separable analysis
from 1988 to 2005 on ages 1 to 15
with Terminal F of .200 on age 11 and Terminal S of 1.000

Initial sum of squared residuals was 878.681 and
final sum of squared residuals is 494.975 after 87 iterations

Matrix of Residuals

Years	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
Ages							
1/ 2	-.404	.564	.735	.405	-.323	-.346	.030
2/ 3	-.404	.564	.735	.405	-.323	-.346	.030
3/ 4	-.404	.564	-3.177	-5.424	-4.571	-.346	.030
4/ 5	-.404	.564	-3.177	-2.507	.495	.501	.030
5/ 6	2.397	3.366	-1.164	.011	2.873	2.455	6.232
6/ 7	4.065	.428	-5.036	-.845	1.005	1.223	1.090
7/ 8	.000	-4.073	-5.122	.692	.131	.476	-.557
8/ 9	-.308	-1.068	-1.710	1.762	.644	.174	-.156
9/10	-.133	-.133	-.284	.381	-.201	-.696	-.556
10/11	.731	.642	.972	.380	.744	.496	.324
11/12	.331	.012	1.353	-.193	.789	.284	-.280
12/13	-.010	-.328	1.342	-.665	.421	.083	-.763
13/14	.133	.037	.948	-.306	-.106	.364	.652
14/15	.876	1.024	1.274	2.179	.333	1.129	.719
TOT	1.187	1.205	1.173	1.076	.959	.795	.606
WTS	.001	.001	.001	.001	.001	.001	.001

Years	1995/96	1996/97	1997/98	1998/99	1999/**	2000/**	2001/**
1/ 2	.138	-.271	.049	-.074	-.577	-.231	.294
2/ 3	.138	-.271	.049	-.074	-.577	-.231	.294
3/ 4	.138	-.271	.049	-2.377	-.577	-2.534	.294
4/ 5	-4.244	-.271	.049	-3.763	-2.774	-5.242	-.400
5/ 6	.636	1.564	-3.758	-3.290	-.974	1.270	1.628
6/ 7	-3.858	-2.997	-.736	.498	-.987	1.102	.114
7/ 8	-1.017	-2.076	-.909	.290	-.465	.908	.002
8/ 9	.040	-.890	.281	.452	-.188	.739	.040
9/10	-.092	-.708	-.289	-.397	-.527	.120	.106
10/11	1.127	.221	.899	.785	.612	.488	.281
11/12	.304	.250	.232	.097	.300	-.041	-.047
12/13	-.096	.614	-.104	.353	1.031	.353	-.724
13/14	.655	1.745	.043	.500	.986	.226	-.714
14/15	.091	2.182	.126	1.191	1.655	.131	-.679
TOT	.443	.312	.198	.123	.063	.012	-.001
WTS	.001	.001	.001	.001	.001	1.000	1.000

Fishing Mortalities (F)

	1988	1989	1990	1991	1992	1993	1994
F-values	.0220	.0171	.0349	.0845	.1471	.1238	.1018

	1996	1997	1998	1999	2000	2001	2002
F-values	.1625	.1440	.1756	.1895	.1237	.1141	.1778

Selection-at-age (S)

	1	2	3	4	5
S-values	.0010	.0010	.0010	.0010	.0010

	6	7	8	9	10	11	12
S-values	.0161	.1411	.3304	.6600	.5828	10.000	.7887

1

Run title : Greenland halibut 1A Disko bay

At 7/06/2006 16:01

SEPARABLY GENERATED FISHING MORTALITIES

YEAR	1988	1989	1990	1991	1992	1993	1994
AGE							
1	.0000	.0000	.0000	.0001	.0001	.0001	.0001
2	.0000	.0000	.0000	.0001	.0001	.0001	.0001
3	.0000	.0000	.0000	.0001	.0001	.0001	.0001
4	.0000	.0000	.0000	.0001	.0001	.0001	.0001
5	.0000	.0000	.0000	.0001	.0001	.0001	.0001
6	.0004	.0003	.0006	.0014	.0024	.0020	.0016
7	.0031	.0024	.0049	.0119	.0208	.0175	.0144
8	.0073	.0056	.0115	.0279	.0486	.0409	.0336
9	.0145	.0113	.0230	.0557	.0971	.0817	.0672
10	.0128	.0099	.0203	.0492	.0858	.0721	.0593
11	.0220	.0171	.0349	.0845	.1471	.1238	.1018
12	.0174	.0135	.0275	.0666	.1160	.0976	.0803
13	.0118	.0091	.0187	.0453	.0789	.0663	.0545
14	.0126	.0098	.0200	.0485	.0844	.0710	.0584
15	.0220	.0171	.0349	.0845	.1471	.1238	.1018

SEPARABLY GENERATED FISHING MORTALITIES

YEAR	1996	1997	1998	1999	2000	2001	2002
AGE							
1	.0002	.0001	.0002	.0002	.0001	.0001	.0002
2	.0002	.0001	.0002	.0002	.0001	.0001	.0002
3	.0002	.0001	.0002	.0002	.0001	.0001	.0002
4	.0002	.0001	.0002	.0002	.0001	.0001	.0002
5	.0002	.0001	.0002	.0002	.0001	.0001	.0002
6	.0026	.0023	.0028	.0031	.0020	.0018	.0029
7	.0229	.0203	.0248	.0268	.0175	.0161	.0251
8	.0537	.0476	.0580	.0626	.0409	.0377	.0587
9	.1072	.0950	.1159	.1251	.0817	.0753	.1173
10	.0947	.0839	.1023	.1105	.0721	.0665	.1036
11	.1625	.1440	.1756	.1895	.1237	.1141	.1778
12	.1282	.1135	.1385	.1495	.0976	.0900	.1402
13	.0871	.0772	.0941	.1016	.0663	.0611	.0953
14	.0933	.0826	.1008	.1088	.0710	.0655	.1020
15	.1625	.1440	.1756	.1895	.1237	.1141	.1778

1

Run title : Greenland halibut 1A Disko bay

At 7/06/2006 16:01

SEPARABLY GENERATED POPULATION NUMBERS

YEAR	1988	1989	1990	1991	1992	1993	1994
AGE							
1	10059	19320	28087	25009	25745	25103	28442
2	4572	8658	16629	24174	21523	22156	21604
3	1410	3935	7452	14312	20805	18523	19068
4	9451	1214	3387	6414	12318	17905	15941
5	5777	8135	1045	2915	5520	10600	15409
6	4891	4973	7001	899	2509	4750	9123
7	5081	4208	4279	6023	773	2154	4080
8	6091	4360	3613	3665	5122	652	1822
9	6092	5205	3731	3075	3067	4200	538
10	5250	5168	4430	3139	2503	2396	3331
11	3360	4461	4404	3736	2572	1977	1919
12	3533	2829	3775	3661	2955	1911	1504
13	3968	2988	2403	3161	2948	2265	1492
14	3713	3375	2549	2030	2600	2345	1824
15	1880	3156	2877	2150	1664	2057	1880

SEPARABLY GENERATED POPULATION NUMBERS

YEAR	1996	1997	1998	1999	2000	2001	2002
AGE							
1	36368	39631	16749	3262	1597	1090	711
2	29769	31297	34106	14414	2807	1375	938
3	21065	25619	26934	29350	12404	2416	1183
4	16001	18128	22047	23178	25257	10675	2079
5	14122	13770	15601	18973	19946	21737	9187
6	11807	12153	11850	13426	16327	17166	18707
7	11392	10135	10436	10171	11520	14025	14747
8	6632	9582	8548	8763	8523	9744	11878
9	2862	5410	7865	6943	7084	7042	8076
10	1204	2213	4234	6028	5273	5619	5622
11	347	943	1751	3290	4646	4223	4525
12	2059	254	703	1265	2343	3533	3243
13	1166	1559	195	527	937	1829	2780
14	963	920	1242	153	410	755	1481
15	976	755	729	967	118	328	609

1

Run title : Greenland halibut 1A Disko bay

At 7/06/2006 16:01

Fishing mortality residuals

YEAR	1988	1989	1990	1991	1992	1993	1994
AGE							
1	.0000	.0000	.0000	-.0001	-.0001	-.0001	-.0001
2	.0000	.0000	.0000	-.0001	-.0001	-.0001	-.0001
3	.0000	.0000	.0000	-.0001	-.0001	-.0001	-.0001
4	.0000	.0000	.0000	.0003	.0020	.0003	-.0001
5	.0000	.0000	.0000	.0006	.0080	.0010	.0001
6	-.0002	-.0003	-.0006	.0005	.0158	.0045	-.0003
7	-.0013	-.0024	-.0047	.0337	.0485	.0326	-.0007
8	.0040	-.0023	-.0055	.1780	.0484	.0870	.0281
9	.0213	.0127	.0171	.1134	.0406	.0064	.1292
10	.0271	.0187	.0302	.0698	.1133	.0592	.0741
11	.0251	.0090	.0189	-.0040	.1195	.0227	.0156
12	.0060	.0076	.0144	-.0403	.0191	-.0125	-.0082
13	.0056	.0034	.0225	-.0273	-.0201	-.0155	-.0113
14	.0064	.0029	.0065	-.0067	-.0405	-.0132	-.0280
15	.0000	-.0064	-.0187	-.0539	-.1337	-.0803	-.0761

Fishing mortality residuals

YEAR	1996	1997	1998	1999	2000	2001	2002
AGE							
1	-.0002	-.0001	-.0002	-.0002	-.0001	-.0001	-.0002
2	-.0002	-.0001	-.0002	-.0002	-.0001	-.0001	-.0002
3	-.0002	-.0001	-.0002	-.0002	-.0001	-.0001	-.0002
4	-.0002	-.0001	-.0002	-.0001	-.0001	.0000	-.0002
5	.0004	-.0001	-.0002	.0000	.0004	.0006	.0000
6	-.0025	-.0006	.0035	.0001	.0045	.0002	.0009
7	-.0189	-.0070	.0148	.0096	.0324	.0013	.0002
8	-.0152	.0195	.0378	.0134	.0502	.0066	.0049
9	.0752	.0757	.0093	.0096	.0412	.0072	.0164
10	.1778	.2559	.1749	.0742	.0642	.0252	-.0011
11	.3339	.2696	.1860	.0768	-.0076	.0244	.0108
12	.0517	.2501	.2758	.1874	.0087	-.0024	.0444
13	.0745	-.0174	.3571	.1661	-.0076	-.0145	.1056
14	.0061	-.0555	-.0277	.3397	.0054	-.0199	.0604
15	-.1070	-.1276	-.1292	-.1513	-.0072	-.0063	.0723

Table 8. XSA output.

Lowestoft VPA Version 3.1

8/06/2006 13:44

Extended Survivors Analysis

Greenland halibut 1A Disko bay

CPUE data from file tun2_6.dat

Catch data for 18 years. 1988 to 2005. Ages 1 to 16.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
Gillnet survey	2001	2005	2	6	.500	.700
Pamiut Disko Bay	1991	2005	1	2	.500	.700

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 13

Terminal population estimation :

Terminal year survivor estimates shrunk towards the mean F of the final 3 years.
S.E. of the mean to which the estimates are shrunk = .500

Oldest age survivor estimates for the years 1988 to 2005
shrunk towards 1.000 * the mean F of ages 12 - 14

S.E. of the mean to which the estimates are shrunk = .500

Minimum standard error for population estimates from each cohort age = .300

Individual fleet weighting not applied

Tuning converged after 136 iterations

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Regression weights

1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000

Fishing mortalities

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
3	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
4	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
5	.001	.000	.000	.000	.000	.001	.000	.000	.000	.000
6	.000	.002	.010	.005	.009	.002	.004	.002	.002	.005
7	.005	.016	.046	.057	.078	.024	.021	.032	.011	.046
8	.040	.083	.118	.088	.148	.071	.089	.054	.064	.037
9	.184	.179	.160	.171	.145	.142	.229	.211	.103	.143
10	.246	.345	.295	.247	.180	.110	.189	.218	.158	.079
11	.450	.361	.369	.289	.165	.192	.235	.517	.414	.281
12	.576	.314	.339	.347	.117	.130	.275	.207	.340	.293
13	.716	.260	.365	.204	.061	.052	.323	.131	.095	.242
14	.887	.173	.415	.327	.056	.047	.183	.145	.143	.094
15	.731	.250	.375	.294	.078	.076	.261	.161	.209	.208

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XSA population numbers (Thousands)

	AGE									
YEAR	1	2	3	4	5	6	7	8	9	10
1996	4.30E+04	2.17E+04	1.41E+04	1.12E+04	1.30E+04	1.03E+04	1.02E+04	8.86E+03	6.03E+03	3.21E+03
1997	3.57E+04	3.70E+04	1.87E+04	1.21E+04	9.60E+03	1.12E+04	8.85E+03	8.70E+03	7.32E+03	4.32E+03
1998	9.63E+04	3.07E+04	3.18E+04	1.61E+04	1.04E+04	8.26E+03	9.62E+03	7.50E+03	6.89E+03	5.27E+03
1999	5.82E+04	8.28E+04	2.64E+04	2.74E+04	1.38E+04	8.96E+03	7.04E+03	7.91E+03	5.74E+03	5.05E+03
2000	9.94E+04	5.01E+04	7.13E+04	2.28E+04	2.36E+04	1.19E+04	7.68E+03	5.73E+03	6.23E+03	4.16E+03
2001	1.77E+05	8.56E+04	4.31E+04	6.14E+04	1.96E+04	2.03E+04	1.02E+04	6.11E+03	4.25E+03	4.64E+03
2002	1.15E+05	1.52E+05	7.37E+04	3.71E+04	5.28E+04	1.68E+04	1.74E+04	8.53E+03	4.90E+03	3.18E+03
2003	1.36E+05	9.89E+04	1.31E+05	6.34E+04	3.20E+04	4.55E+04	1.44E+04	1.47E+04	6.72E+03	3.35E+03
2004	1.08E+05	1.17E+05	8.52E+04	1.13E+05	5.46E+04	2.75E+04	3.91E+04	1.20E+04	1.20E+04	4.68E+03
2005	8.00E+04	9.29E+04	1.01E+05	7.33E+04	9.71E+04	4.70E+04	2.36E+04	3.33E+04	9.72E+03	9.30E+03

Estimated population abundance at 1st Jan 2006

0.00E+00	6.88E+04	7.99E+04	8.69E+04	6.31E+04	8.35E+04	4.02E+04	1.94E+04	2.76E+04	7.25E+03

Taper weighted geometric mean of the VPA populations:

4.70E+04 3.71E+04 2.84E+04 2.13E+04 1.59E+04 1.14E+04 8.43E+03 6.22E+03 4.20E+03 2.78E+03

Standard error of the weighted Log(VPA populations) :

.7843 .8089 .8173 .8044 .7994 .7237 .6953 .7015 .6166 .6165

YEAR	AGE 11	12	13	14	15
1996	1.35E+03	6.72E+02	3.06E+02	1.37E+02	9.14E+01
1997	2.16E+03	7.40E+02	3.25E+02	1.29E+02	4.88E+01
1998	2.63E+03	1.30E+03	4.65E+02	2.16E+02	9.31E+01
1999	3.38E+03	1.57E+03	7.95E+02	2.78E+02	1.23E+02
2000	3.40E+03	2.18E+03	9.52E+02	5.58E+02	1.73E+02
2001	2.99E+03	2.48E+03	1.67E+03	7.71E+02	4.54E+02
2002	3.58E+03	2.12E+03	1.87E+03	1.36E+03	6.33E+02
2003	2.26E+03	2.44E+03	1.39E+03	1.17E+03	9.78E+02
2004	2.32E+03	1.16E+03	1.71E+03	1.05E+03	8.70E+02
2005	3.44E+03	1.32E+03	7.12E+02	1.33E+03	7.82E+02

Estimated population abundance at 1st Jan 2006

7.40E+03 2.24E+03 8.48E+02 4.81E+02 1.05E+03

Taper weighted geometric mean of the VPA populations:

1.64E+03 9.24E+02 5.61E+02 3.61E+02 2.13E+02

Standard error of the weighted Log(VPA populations) :

.6176 .6523 .7133 .8296 .9102

1

Log catchability residuals.

Fleet : Gillnet survey

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	No data for this fleet at this age									
2	99.99	99.99	99.99	99.99	99.99	.15	-.60	2.43	-1.17	-.80
3	99.99	99.99	99.99	99.99	99.99	.35	-1.06	.41	.19	.12
4	99.99	99.99	99.99	99.99	99.99	.34	-.22	-.02	-.25	.15
5	99.99	99.99	99.99	99.99	99.99	1.17	-.73	.11	-.01	-.54
6	99.99	99.99	99.99	99.99	99.99	.83	.05	-.52	.05	-.41

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6
Mean Log q	-84.683	-41.851	-34.208	-27.191	-21.241
S.E(Log q)	14.387	.6040	.2484	.7437	.5299

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	-.95	-.598	14.54	.03	5	1.49	-8.47
3	.86	.199	5.20	.39	5	.59	-4.19
4	1.03	-.086	3.18	.71	5	.30	-3.42
5	-16.88	-2.933	145.49	.01	5	7.37	-2.72
6	8.05	-2.066	-55.30	.03	5	3.16	-2.12
1							

Fleet : Pamiut Disko Bay

Age	1991	1992	1993	1994	1995
1	-.18	.58	-.71	-.28	.24
2	-.67	.89	.41	.03	.69
3	No data for this fleet at this age				
4	No data for this fleet at this age				
5	No data for this fleet at this age				
6	No data for this fleet at this age				

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	.07	-.29	.34	-.05	.27	.07	-.34	.11	.17	.00
2	.56	.83	.96	-.72	-.68	-.71	-.62	.01	-.38	-.59
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2
Mean Log q	-44.049	-46.318
S.E(Log q)	.3219	.6635

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	.89	1.182	5.13	.90	15	.28	-4.40
2	2.09	-2.969	-1.92	.36	15	1.11	-4.63

1

Fleet disaggregated estimates of survivors :

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Gillnet survey

Age	1
Survivors	0.
Raw Weights	.000
Std. err.	.000
Recip.ECF.	.000

Pamiut Disko Bay

Age	1
Survivors	68835.
Raw Weights	9.046
Std. err.	.332
Recip.ECF.	1.000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F	
Gillnet survey	1.	.000	.000	.00	0	.000	.000	
Pamiut Disko Bay	68835.	.332	.000	.00	1	1.000	.000	
F shrinkage mean	0.	.50				.000	.000	

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
68835.	.33	.00	1	.000	.000

1

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Gillnet survey

Age	2	1
Survivors	35871.	0.
Raw Weights	.403	.000

Std. err.	1.576	.000
Recip.ECF.	1.000	.000

Pamiut Disko Bay

Age	2	1
Survivors	44489.	95074.
Raw Weights	2.129	9.046
Std. err.	.685	.332
Recip.ECF.	1.000	1.000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights		Estimated F
Gillnet survey	35871.	1.576	.000	.00	1	.035		.000
Pamiut Disko Bay	82266.	.299	.298	1.00	2	.965		.000
F shrinkage mean	0.	.50					.000	.000

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
79925.	.29	.23	3	.794	.000

1

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Gillnet survey

Age	3	2	1
Survivors	97572.	27015.	0.
Raw Weights	2.284	.403	.000
Std. err.	.662	1.576	.000
Recip.ECF.	1.000	1.000	.000

Pamiut Disko Bay

Age	3	2	1
Survivors	0.	59186.	97363.
Raw Weights	.000	2.129	9.046
Std. err.	.000	.685	.332
Recip.ECF.	.000	1.000	1.000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights		Estimated F
Gillnet survey	80492.	.610	.458	.75	2	.194		.000
Pamiut Disko Bay	88553.	.299	.195	.65	2	.806		.000
F shrinkage mean	0.	.50					.000	.000

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
86930.	.27	.16	4	.581	.000

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Gillnet survey

Age	4	3	2	1
Survivors	73148.	76312.	714178.	0.
Raw Weights	11.111	2.284	.403	.000
Std. err.	.272	.662	1.576	.000
Recip.ECF.	1.000	1.000	1.000	.000

Pamiut Disko Bay

Age	4	3	2	1
Survivors	0.	0.	63911.	44874.
Raw Weights	.000	.000	2.129	9.046
Std. err.	.000	.000	.685	.332
Recip.ECF.	.000	.000	1.000	1.000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights		Estimated F
Gillnet survey	78727.	.269	.271	1.00	3	.552		.000
Pamiut Disko Bay	48002.	.299	.139	.46	2	.448		.000
F shrinkage mean	0.	.50					.000	.000

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
63091.	.20	.19	5	.968	.000

1

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2000

Gillnet survey

Age	5	4	3	2	1
Survivors	48590.	64885.	125667.	45739.	0.
Raw Weights	1.507	11.110	2.284	.403	.000
Std. err.	.815	.272	.662	1.576	.000

Recip.ECF.	1.000	1.000	1.000	1.000	.000

Pamiut Disko Bay

Age	5	4	3	2	1
Survivors	0.	0.	0.	44828.	89589.
Raw Weights	.000	.000	.000	2.129	9.045
Std. err.	.000	.000	.000	.685	.332
Recip.ECF.	.000	.000	.000	1.000	1.000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Gillnet survey	68965.	.256	.156	.61	4	.502	.000
Pamiut Disko Bay	78516.	.299	.272	.91	2	.367	.000
Fshrinkage mean	206966.	.50				.131	.000

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
83545.	.18	.19	7	1.034	.000

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1999

Gillnet survey

Age	6	5	4	3	2	1
Survivors	26760.	39753.	39505.	13930.	46504.	0.
Raw Weights	2.952	1.499	11.051	2.272	.400	.000
Std. err.	.581	.815	.272	.662	1.576	.000
Recip.ECF.	.995	.995	.995	.995	.995	.000

Pamiut Disko Bay

Age	6	5	4	3	2	1
Survivors	0.	0.	0.	0.	19692.	52621.
Raw Weights	.000	.000	.000	.000	2.118	8.998
Std. err.	.000	.000	.000	.000	.685	.332
Recip.ECF.	.000	.000	.000	.000	.995	.995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Gillnet survey	32687.	.234	.177	.76	5	.546	.007
Pamiut Disko Bay	43633.	.299	.386	1.29	2	.334	.005
Fshrinkage mean	82081.	.50				.120	.003

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
40208.	.17	.18	8	1.012	.005

1

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1998

Gillnet survey

Age	7	6	5	4	3	2	1
Survivors	0.	20408.	21787.	15654.	27447.	0.	0.
Raw Weights	.000	2.829	1.436	10.591	2.177	.000	.000
Std. err.	.000	.581	.815	.272	.662	.000	.000
Recip.ECF.	.000	.953	.953	.953	.953	.000	.000

Pamiut Disko Bay

Age	7	6	5	4	3	2	1
Survivors	0.	0.	0.	0.	0.	9842.	18491.
Raw Weights	.000	.000	.000	.000	.000	2.030	8.623
Std. err.	.000	.000	.000	.000	.000	.685	.332
Recip.ECF.	.000	.000	.000	.000	.000	.953	.953

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Gillnet survey	18073.	.237	.116	.49	4	.538	.049
Pamiut Disko Bay	16398.	.299	.248	.83	2	.336	.054
F shrinkage mean	41440.	.50				.126	.022

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
19423.	.17	.15	7	.876	.046

1

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Gillnet survey

Age	8	7	6	5	4	3	2	1
Survivors	0.	0.	16435.	13262.	38662.	0.	0.	0.
Raw Weights	.000	.000	2.822	1.433	10.567	.000	.000	.000

Std. err.	.000	.000	.581	.815	.272	.000	.000	.000
Recip.ECF.	.000	.000	.951	.951	.951	.000	.000	.000

Pamiut Disko Bay

Age	8	7	6	5	4	3	2	1
Survivors	0.	0.	0.	0.	0.	0.	13463.	38815.
Raw Weights	.000	.000	.000	.000	.000	.000	2.025	8.604
Std. err.	.000	.000	.000	.000	.000	.000	.685	.332
Recip.ECF.	.000	.000	.000	.000	.000	.000	.951	.951

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Gillnet survey	29622.	.253	.299	1.18	3	.503	.035
Pamiut Disko Bay	31723.	.299	.416	1.39	2	.361	.032
Fshrinkage mean	14570.	.50				.136	.069

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
27574.	.18	.21	6	1.183	.037

1

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Gillnet survey

Age	9	8	7	6	5	4	3	2	1
Survivors	0.	0.	0.	7602.	23370.	0.	0.	0.	0.
Raw Weights	.000	.000	.000	2.327	1.181	.000	.000	.000	.000
Std. err.	.000	.000	.000	.581	.815	.000	.000	.000	.000
Recip.ECF.	.000	.000	.000	.784	.784	.000	.000	.000	.000

Pamiut Disko Bay

Age	9	8	7	6	5	4	3	2	1
Survivors	0.	0.	0.	0.	0.	0.	0.	19014.	5421.
Raw Weights	.000	.000	.000	.000	.000	.000	.000	1.669	7.088
Std. err.	.000	.000	.000	.000	.000	.000	.000	.685	.332
Recip.ECF.	.000	.000	.000	.000	.000	.000	.000	.784	.784

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Gillnet survey	11094.	.473	.531	1.12	2	.216	.096
Pamiut Disko Bay	6885.	.299	.493	1.65	2	.538	.150
Fshrinkage mean	5594.	.50				.246	.181

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7251.	.23	.25	5	1.115	.143

1

Age 10 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Gillnet survey

Age	10	9	8	7	6	5	4	3	2	1
Survivors	0.	0.	0.	0.	16924.	0.	0.	0.	0.	0.
Raw Weights	.000	.000	.000	.000	2.291	.000	.000	.000	.000	.000
Std. err.	.000	.000	.000	.000	.581	.000	.000	.000	.000	.000
Recip.ECF.	.000	.000	.000	.000	.772	.000	.000	.000	.000	.000

Pamiut Disko Bay

Age	10	9	8	7	6	5	4	3	2	1
Survivors	0.	0.	0.	0.	0.	0.	0.	0.	16881.	7926.
Raw Weights	.000	.000	.000	.000	.000	.000	.000	.000	1.643	6.981
Std. err.	.000	.000	.000	.000	.000	.000	.000	.000	.685	.332
Recip.ECF.	.000	.000	.000	.000	.000	.000	.000	.000	.772	.772

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Gillnet survey	16924.	.581	.000	.00	1	.154	.035
Pamiut Disko Bay	9154.	.299	.297	.99	2	.578	.064
Fshrinkage mean	2908.	.50				.268	.189

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7397.	.24	.42	4	1.784	.079

1

Age 11 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Gillnet survey

Age	11
Survivors	0.

Raw Weights	.000									
Std. err.	.000									
Recip.ECF.	.000									
Age	10	9	8	7	6	5	4	3	2	1
Survivors	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Raw Weights	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Std. err.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Recip.ECF.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Pamiut Disko Bay

Age	11									
Survivors	0.									
Raw Weights	.000									
Std. err.	.000									
Recip.ECF.	.000									
Age	10	9	8	7	6	5	4	3	2	1
Survivors	0.	0.	0.	0.	0.	0.	0.	0.	3900.	2834.
Raw Weights	.000	.000	.000	.000	.000	.000	.000	.000	.983	4.175
Std. err.	.000	.000	.000	.000	.000	.000	.000	.000	.685	.332
Recip.ECF.	.000	.000	.000	.000	.000	.000	.000	.000	.462	.462

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights		Estimated F
Gillnet survey	1.	.000	.000	.00	0	.000		.000
Pamiut Disko Bay	3012.	.299	.125	.42	2	.563		.216
F shrinkage mean	1522.	.50					.437	.390

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2235.	.28	.33	3	1.182	.281

1

Age 12 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Gillnet survey

Age	12	11								
Survivors	0.	0.								
Raw Weights	.000	.000								
Std. err.	.000	.000								
Recip.ECF.	.000	.000								
Age	10	9	8	7	6	5	4	3	2	1
Survivors	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Raw Weights	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Std. err.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Recip.ECF.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Pamiut Disko Bay

Age	12	11
Survivors	0.	0.
Raw Weights	.000	.000
Std. err.	.000	.000
Recip.ECF.	.000	.000

Age	10	9	8	7	6	5	4	3	2	1
Survivors	0.	0.	0.	0.	0.	0.	0.	0.	1691.	640.
Raw Weights	.000	.000	.000	.000	.000	.000	.000	.000	.575	2.444
Std. err.	.000	.000	.000	.000	.000	.000	.000	.000	.685	.332
Recip.ECF.	.000	.000	.000	.000	.000	.000	.000	.000	.270	.270

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights		Estimated F
Gillnet survey	1.	.000	.000	.00	0	.000		.000
Pamiut Disko Bay	770.	.299	.382	1.28	2	.430		.318
Fshrinkage mean	911.	.50					.570	.275

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
848.	.31	.20	3	.635	.293

1

Age 13 Catchability constant w.r.t. time and dependent on age

Year class = 1992

Gillnet survey

Age	13	12	11
Survivors	0.	0.	0.
Raw Weights	.000	.000	.000
Std. err.	.000	.000	.000
Recip.ECF.	.000	.000	.000

Age	10	9	8	7	6	5	4	3	2	1
Survivors	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Raw Weights	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Std. err.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Recip.ECF.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Pamiut Disko Bay

Age	13	12	11
Survivors	0.	0.	0.
Raw Weights	.000	.000	.000
Std. err.	.000	.000	.000
Recip.ECF.	.000	.000	.000

Age	10	9	8	7	6	5	4	3	2	1
Survivors	0.	0.	0.	0.	0.	0.	0.	0.	495.	236.
Raw Weights	.000	.000	.000	.000	.000	.000	.000	.000	.411	1.748
Std. err.	.000	.000	.000	.000	.000	.000	.000	.000	.685	.332
Recip.ECF.	.000	.000	.000	.000	.000	.000	.000	.000	.193	.193

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Gillnet survey	1.	.000	.000	.00	0	.000	.000
Pamiut Disko Bay	272.	.299	.291	.97	2	.351	.395
F shrinkage mean	654.	.50				.649	.184

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
481.	.34	.51	3	1.506	.242

1

Age 14 Catchability constant w.r.t. time and age (fixed at the value for age) 13

Year class = 1991

Gillnet survey

Age	14	13	12	11
Survivors	0.	0.	0.	0.
Raw Weights	.000	.000	.000	.000
Std. err.	.000	.000	.000	.000
Recip.ECF.	.000	.000	.000	.000

Age	10	9	8	7	6	5	4	3	2	1
Survivors	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Raw Weights	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Std. err.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Recip.ECF.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Pamiut Disko Bay

Age	14	13	12	11
Survivors	0.	0.	0.	0.
Raw Weights	.000	.000	.000	.000

Std. err.	.000	.000	.000	.000							
Recip.ECF.	.000	.000	.000	.000							
Age	10	9	8	7	6	5	4	3	2	1	
Survivors	0.	0.	0.	0.	0.	0.	0.	0.	1571.	1863.	
Raw Weights	.000	.000	.000	.000	.000	.000	.000	.000	.766	3.255	
Std. err.	.000	.000	.000	.000	.000	.000	.000	.000	.685	.332	
Recip.ECF.	.000	.000	.000	.000	.000	.000	.000	.000	.360	.360	

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Gillnet survey	1.	.000	.000	.00	0	.000	.000
Pamiut Disko Bay	1803.	.299	.067	.22	2	.501	.056
F shrinkage mean	605.	.50				.499	.157

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1046.	.29	.55	3	1.879	.094

1

Age 15 Catchability constant w.r.t. time and age (fixed at the value for age) 13

Year class = 1990

Gillnet survey

Age	15	14	13	12	11						
Survivors	0.	0.	0.	0.	0.						
Raw Weights	.000	.000	.000	.000	.000						
Std. err.	.000	.000	.000	.000	.000						
Recip.ECF.	.000	.000	.000	.000	.000						
Age	10	9	8	7	6	5	4	3	2	1	
Survivors	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
Raw Weights	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	
Std. err.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	
Recip.ECF.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	

Pamiut Disko Bay

Age	15	14	13	12	11						
Survivors	0.	0.	0.	0.	0.						
Raw Weights	.000	.000	.000	.000	.000						
Std. err.	.000	.000	.000	.000	.000						
Recip.ECF.	.000	.000	.000	.000	.000						
Age	10	9	8	7	6	5	4	3	2	1	
Survivors	0.	0.	0.	0.	0.	0.	0.	0.	1328.	457.	
Raw Weights	.000	.000	.000	.000	.000	.000	.000	.000	.507	2.155	

Std. err.	.000	.000	.000	.000	.000	.000	.000	.000	.685	.332
Recip.ECF.	.000	.000	.000	.000	.000	.000	.000	.000	.238	.238

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights		Estimated F
Gillnet survey	1.	.000	.000	.00	0	.000		.000
Pamiut Disko Bay	560.	.299	.419	1.40	2	.400		.203
F shrinkage mean	539.	.50					.600	.210

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
547.	.32	.19	3	.584	.208

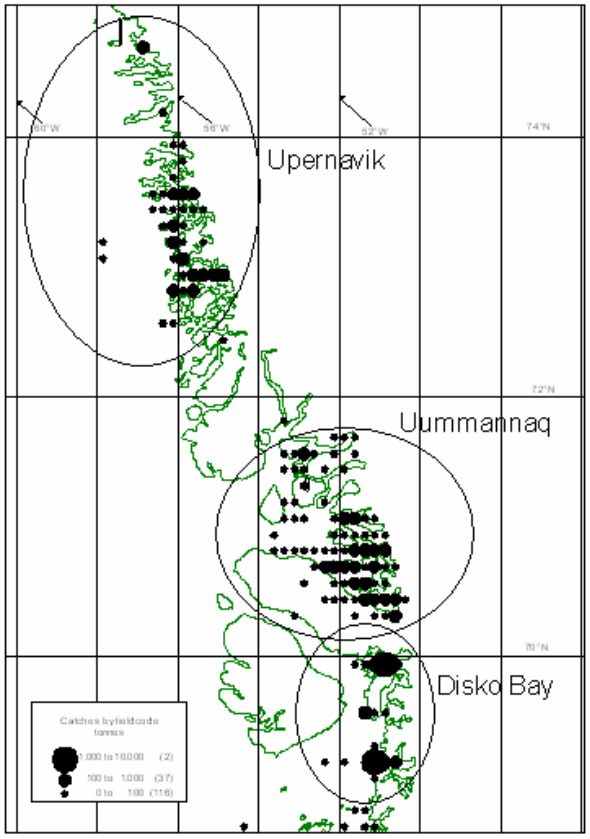

Fig. 1. Distribution of the inshore fishery for Greenland halibut in Div.1A in 2005. Landings is shown in tons per. Square (field-code). Catch statistics are provisional.

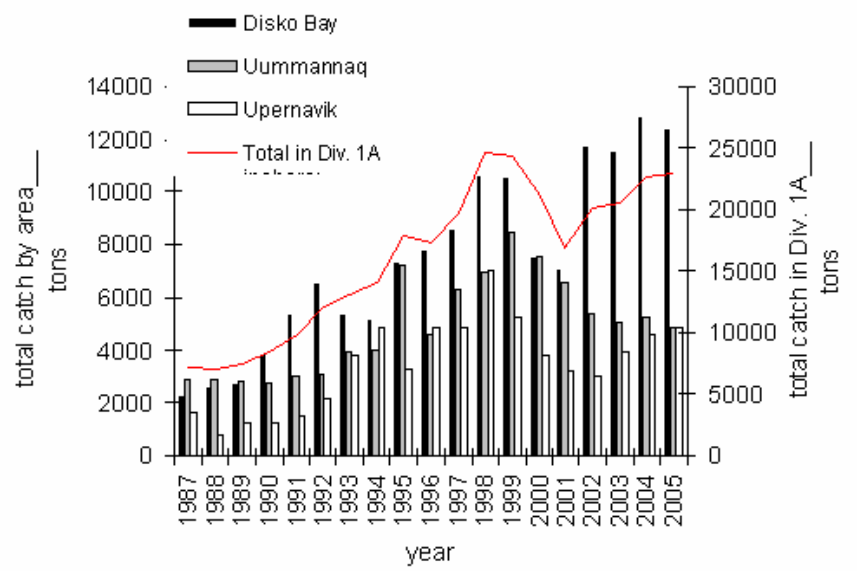

Fig. 2. Landings in NAFO Div. 1A since 1987 for the 3 main fishing areas. Data on landings from 2000-2005 are provisional. See also Table 1.

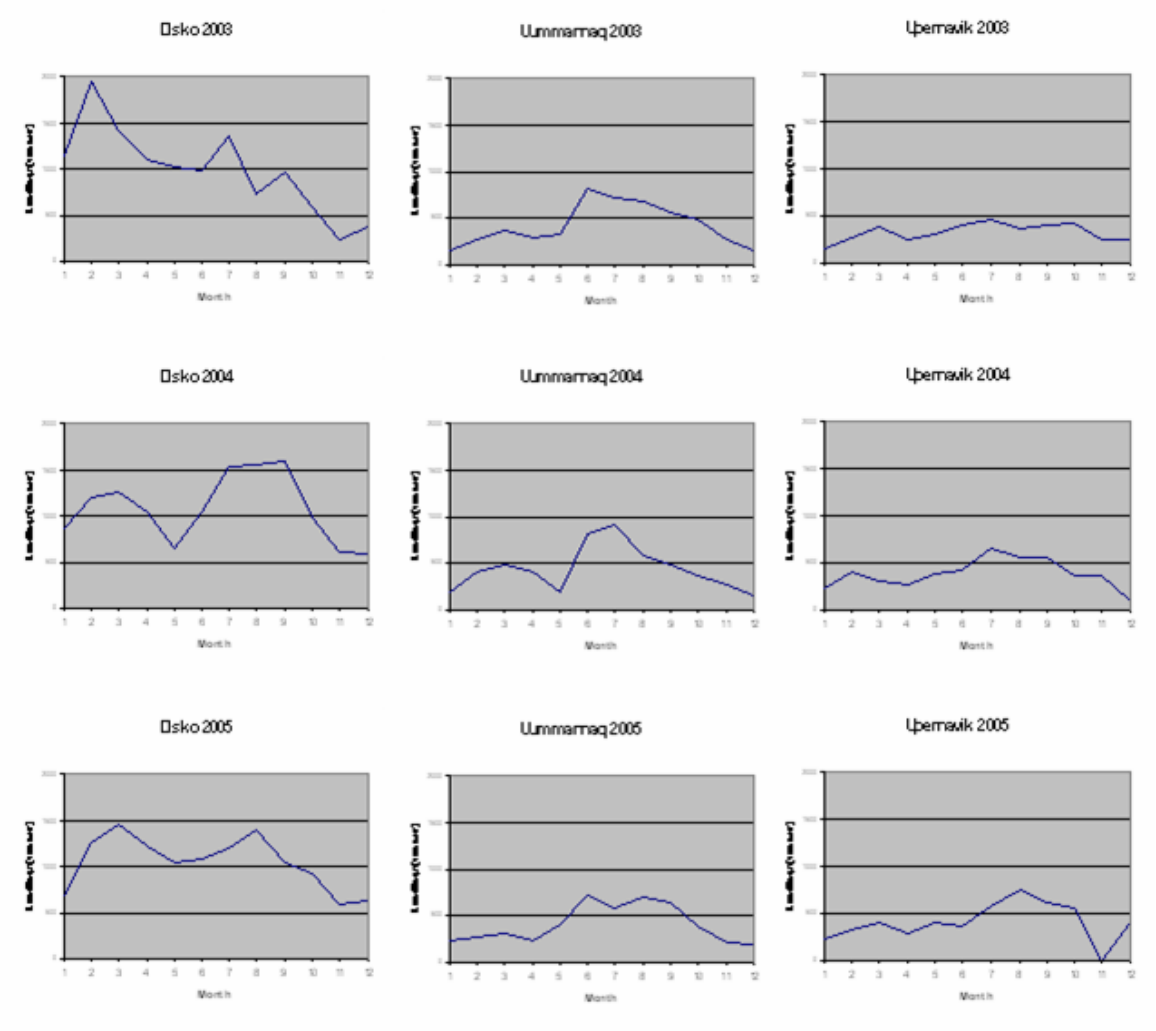

Fig. 3. Landings in NAFO Div.1A inshore by month and area for the years 2002-2004.

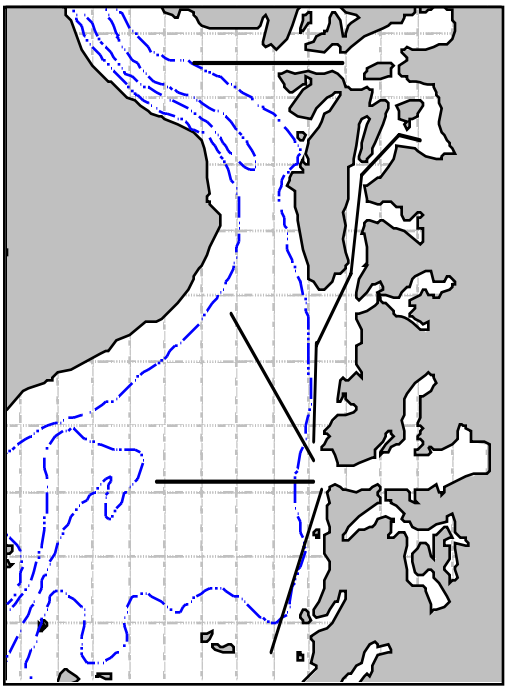

Fig. 4. Map of area in Disko Bay for gillnet survey. Lines are transects along which fixed stations are positioned.

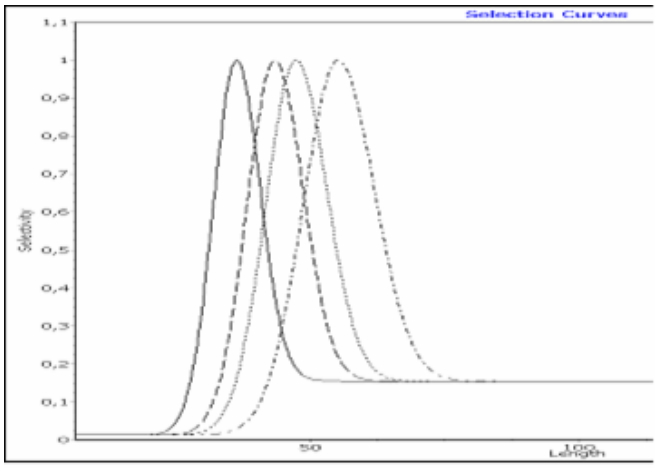

Fig. 5. Assumed selectivity curve applied to gillnet survey catches (Wileman's wings).

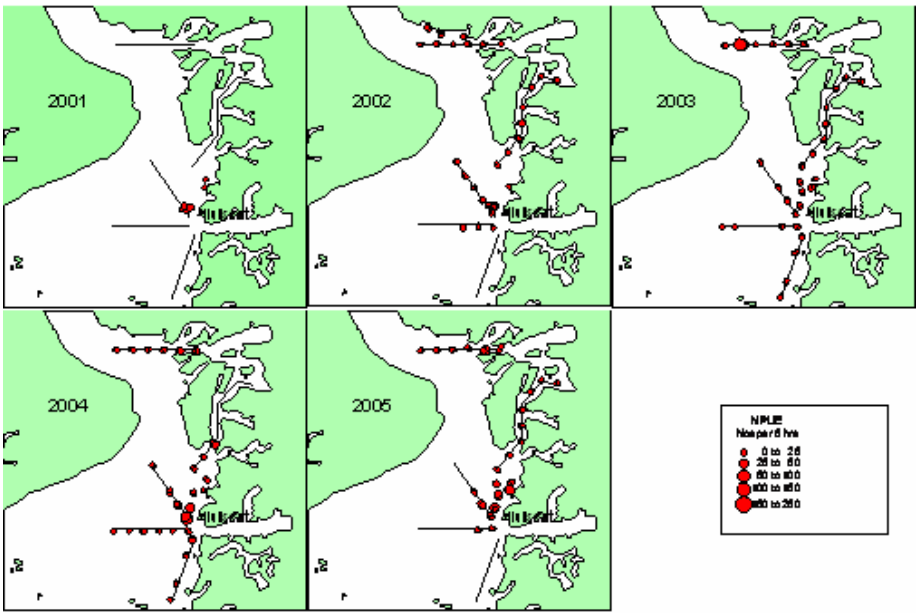

Fig. 6. Gillnet survey in Disko Bay 2001-2005. NPUE distribution (Nos G.halibut per 6 hrs of setting).

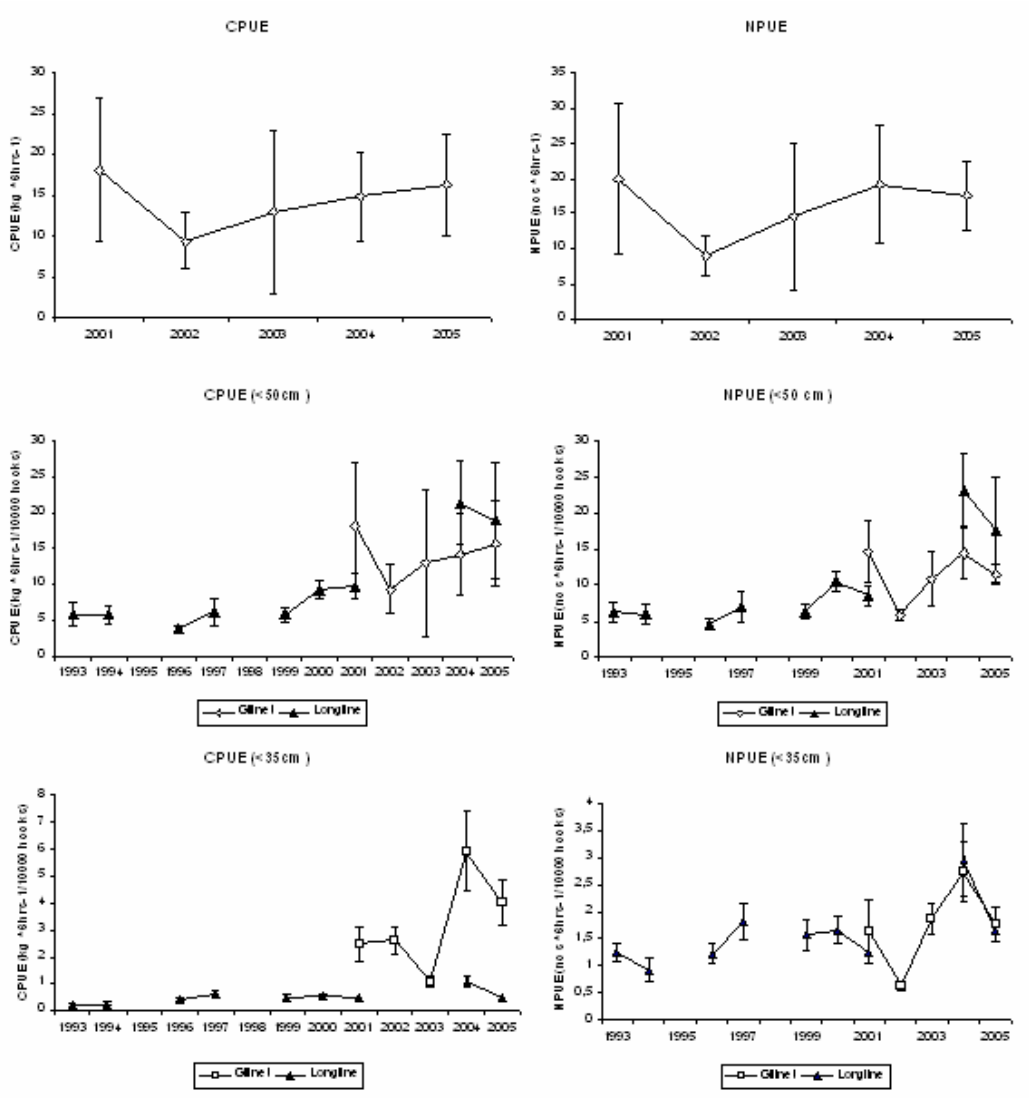

Fig. 7. Upper: Standardised catch rates from gillnet survey in Disko bay (1A) in weight (CPUE) and numbers (NPUE). Middle and lower: CPUE/NPUE by length < 50 cm and <35cm, respectively, for both gillnet and longline survey.

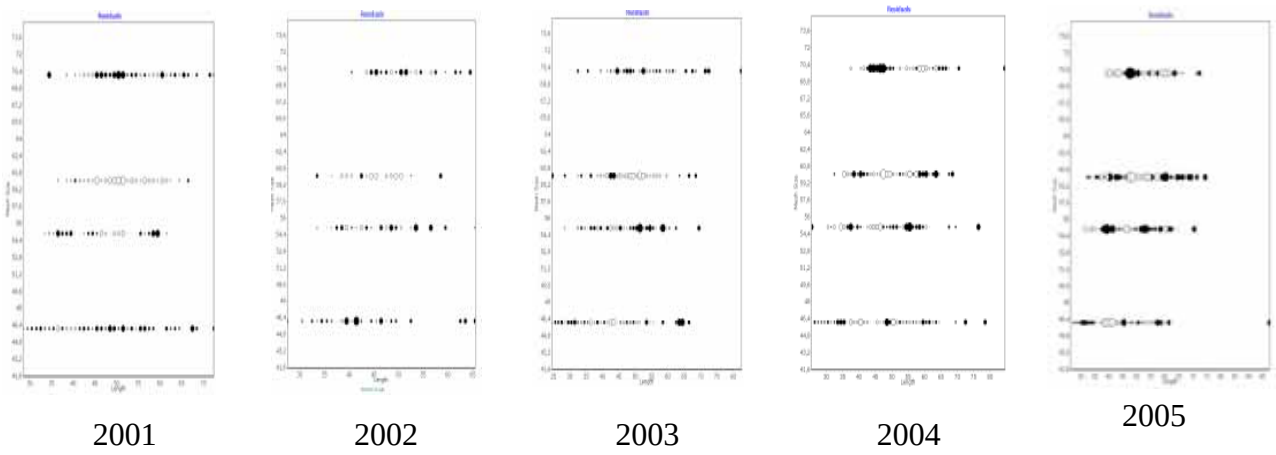

Fig. 8a. Residuals for each mesh size (y-axis) by length (x-axis) from the selectivity model (Wilemans Wings) 2001-2005.

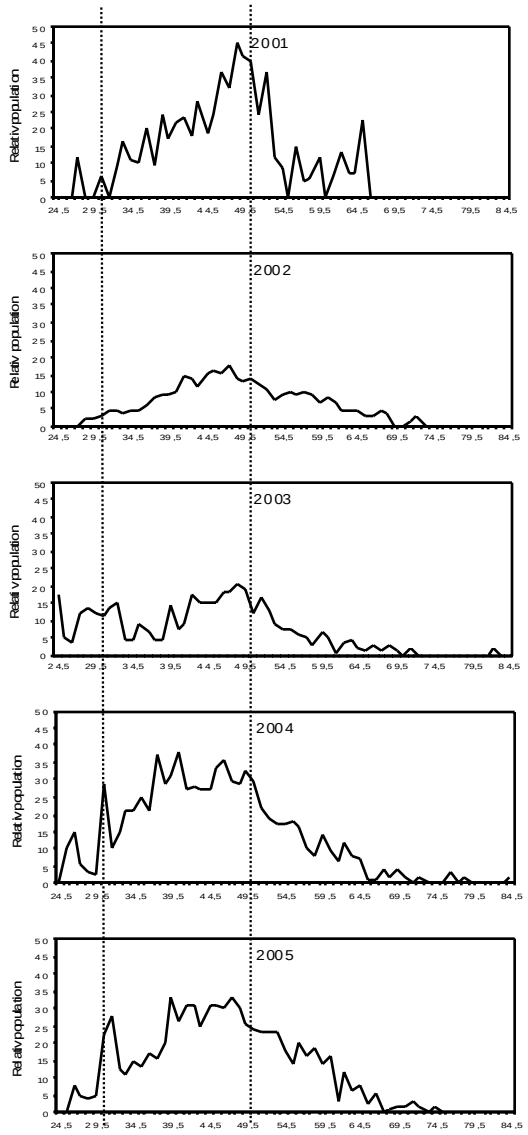

Fig. 8b. Estimated relative population assuming a Wilemans Wings selectivity curve in 2001 to 2005 (from top to bottom): the dashed lines indicate the length interval 30 – 50 cm where fully selection is assumed.

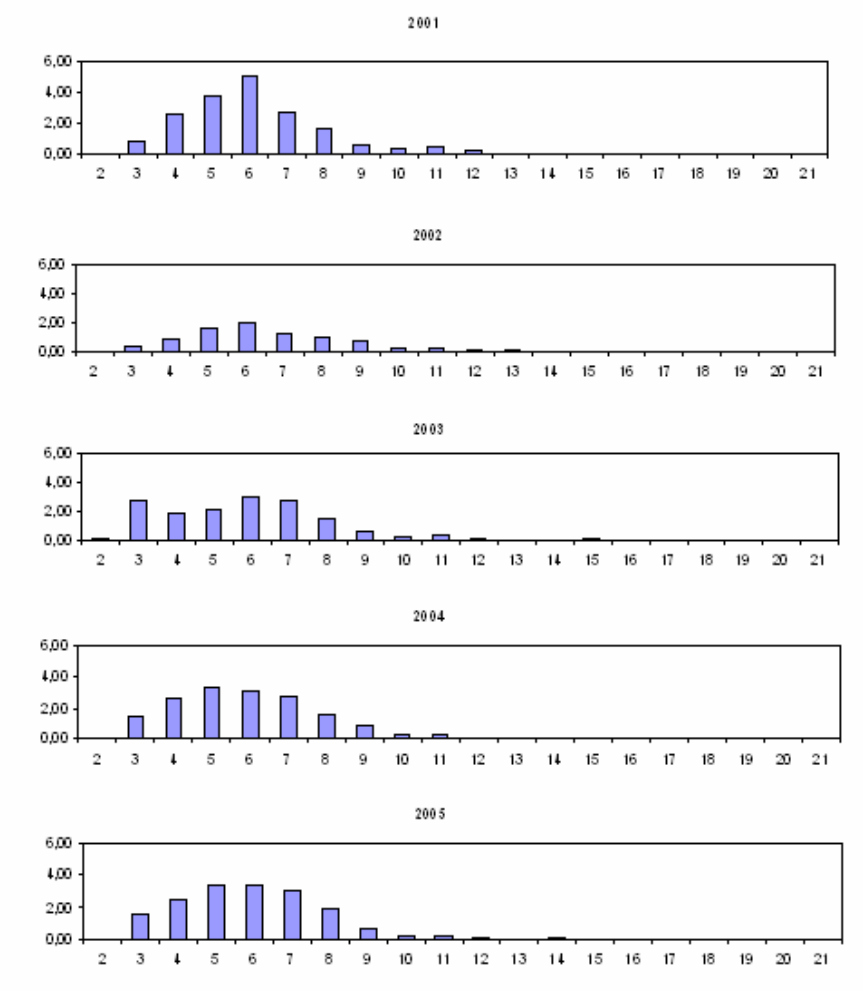

Fig. 9. Gillnet survey in Disko bay. Abundance (estimated relative population) by age.

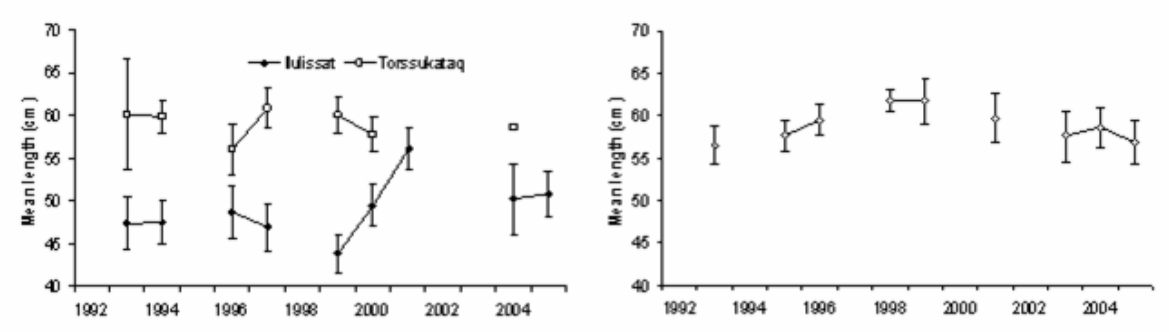

Fig. 10. Mean length for longline surveys conducted since 1993. 95% CI indicated.

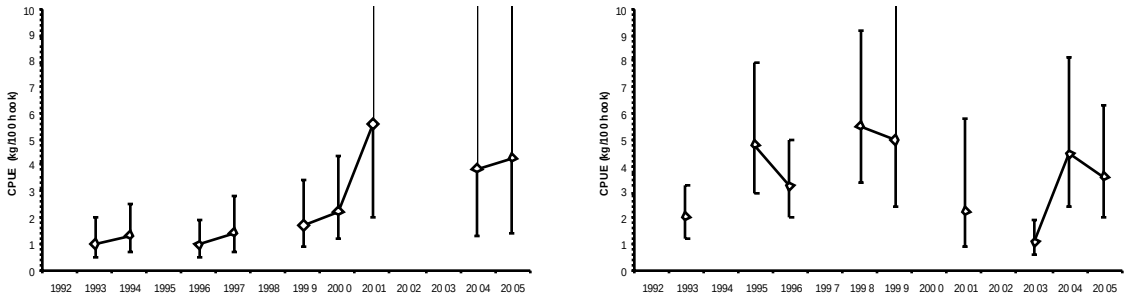

Fig. 11. Longline survey index (standardised CPUE) for Ilulissat (left) and Uummannaq (right) 1993-2005. 95% CI indicated.

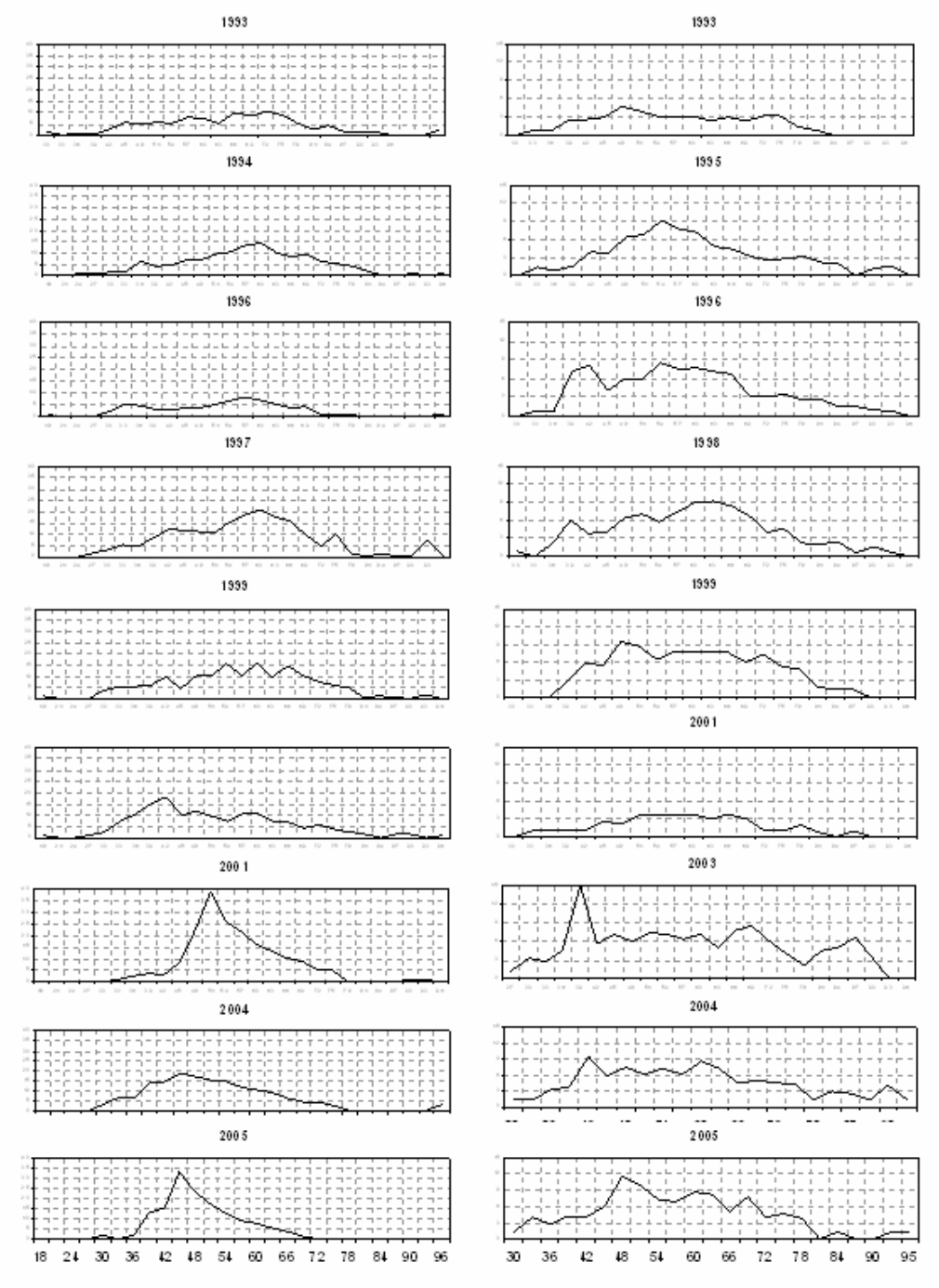

Fig. 12. NPUE (nos/1000 hooks) by length group (3 cm) of Greenland halibut from longline surveys. **Right:Uummannaq, Left: Ilulissat.**

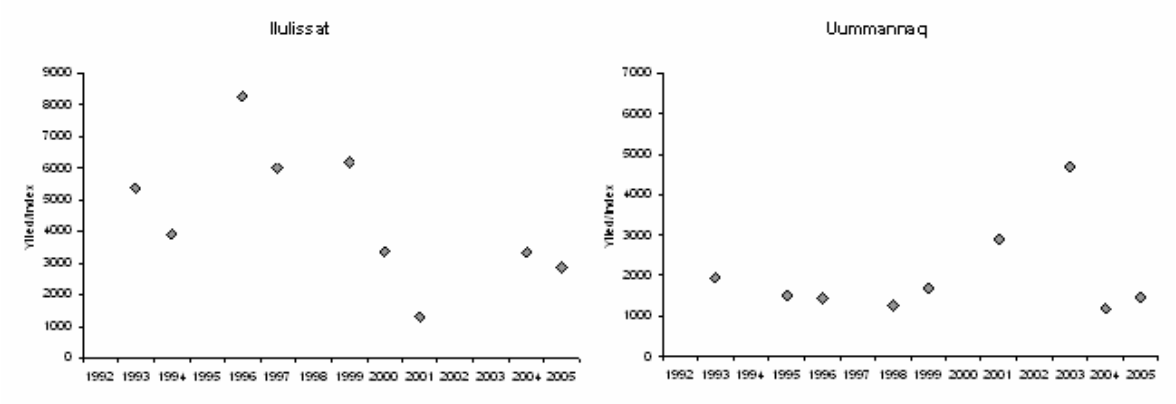

Fig. 13a. Exploitation proxies (Landings/standardized survey index) for Ilulissat and Uummannaq.

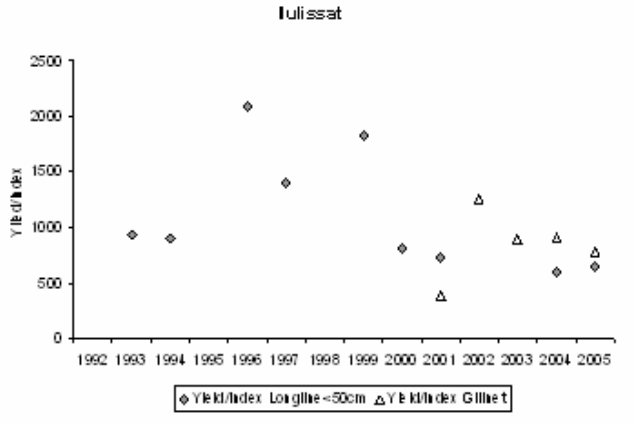

Fig. 13b. Exploitation proxy (Landings/standardized survey index) for Ilulissat for Gillnet survey catch rates and calibrated longline survey catch rates (see section XX).

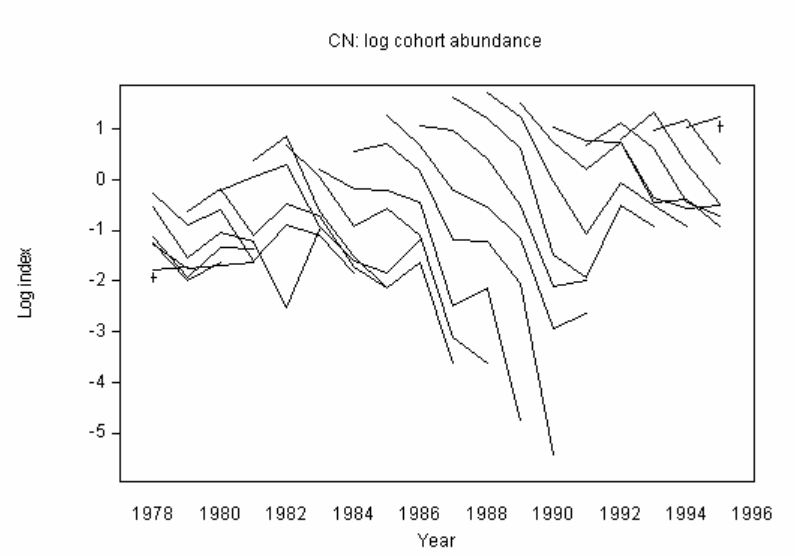

Fig. 14. Greenland halibut Disko Bay 1A; Catch curves of cohort's including ages 10-16.

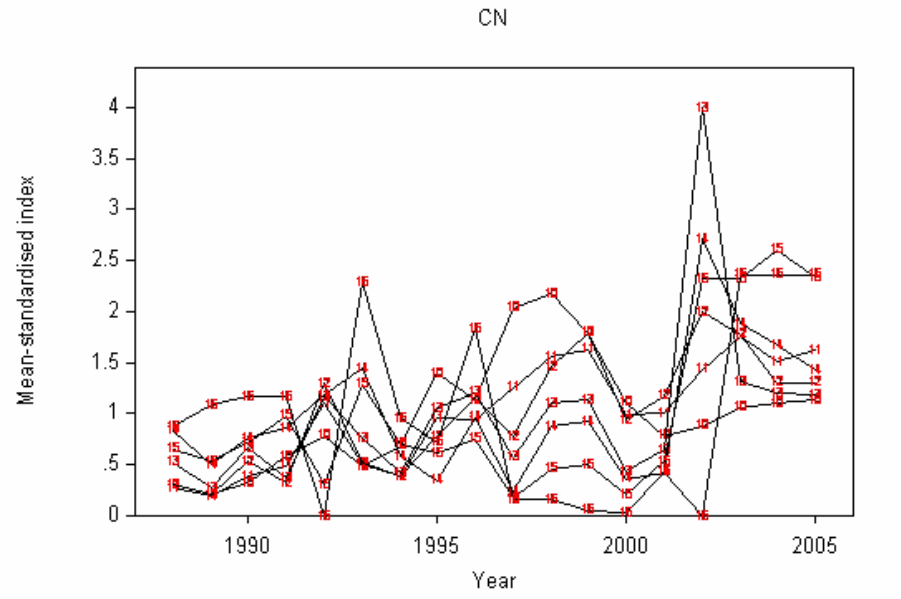

Fig. 15. Greenland halibut Disko Bay 1A; Mean standardised Catch at age.

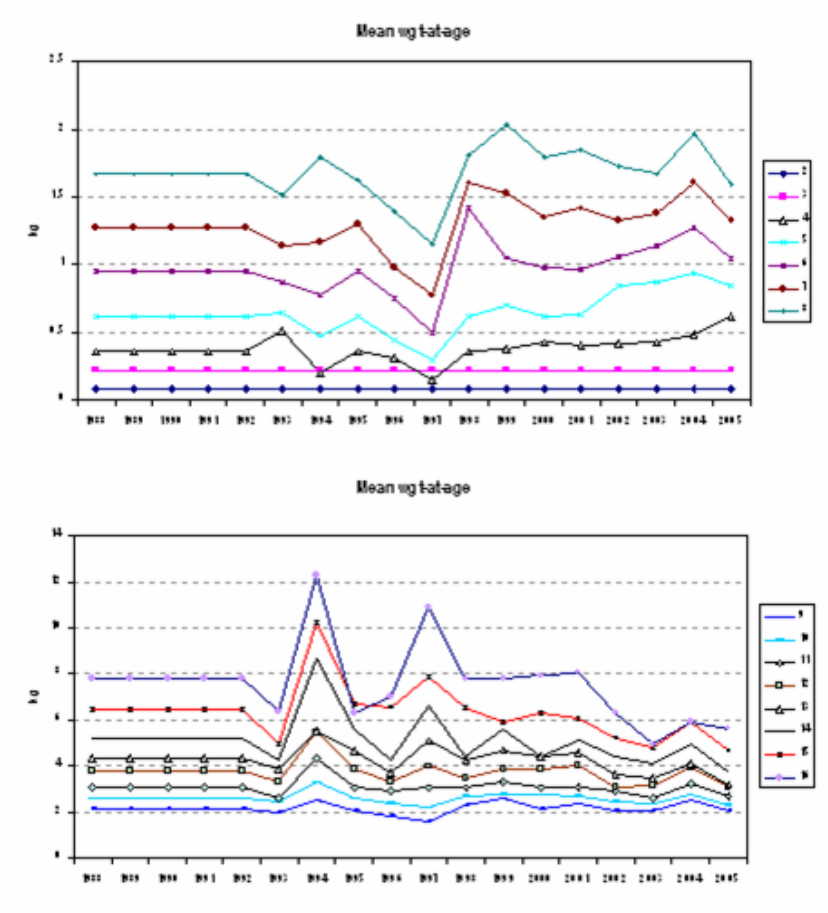

Fig. 16. Mean wgt-at-age in stock and catches.

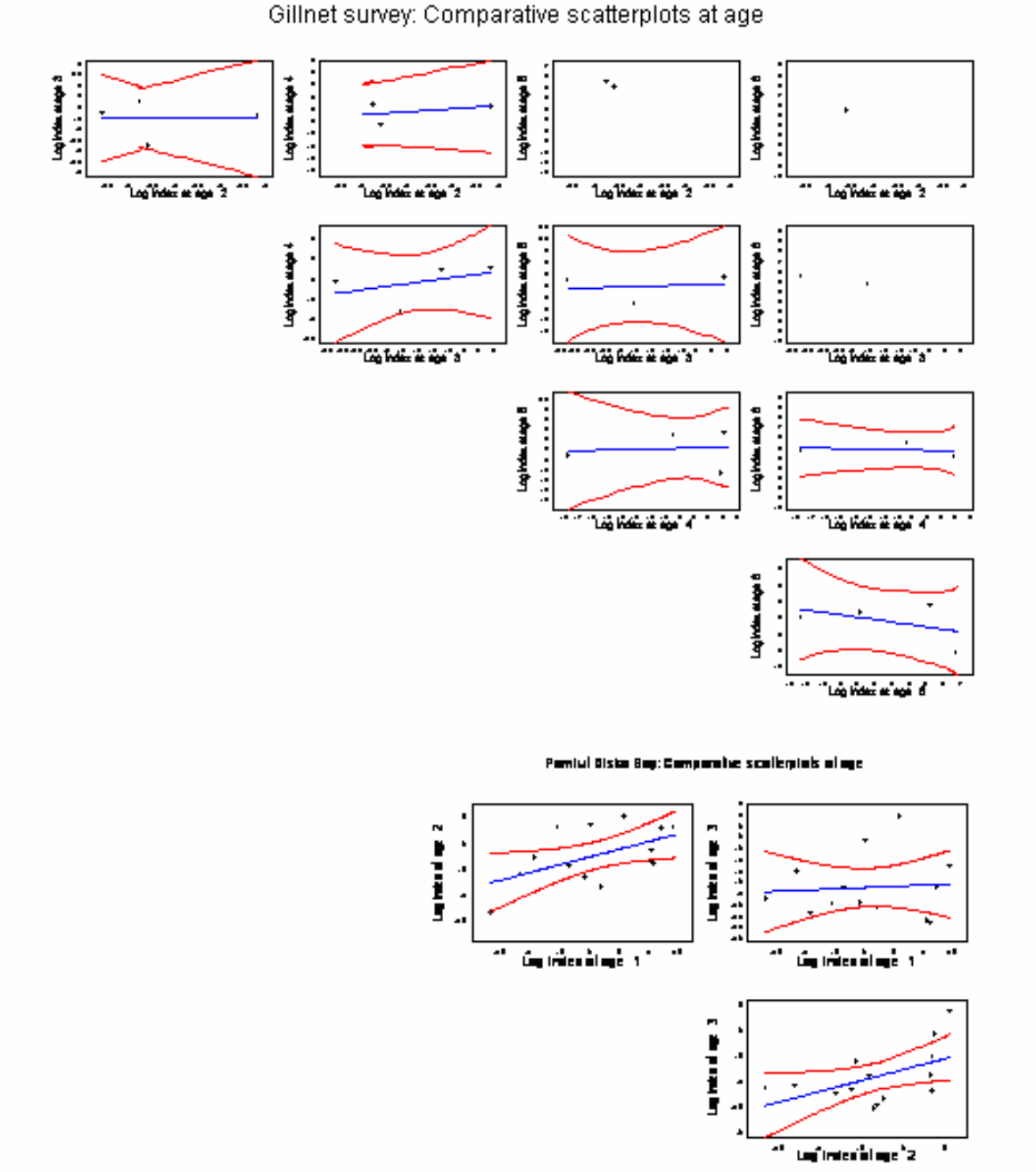

Fig. 17. Matrix plots of survey indices (log values) Upper: Gillnet survey, Lower: Pamiut Disko Bay survey.

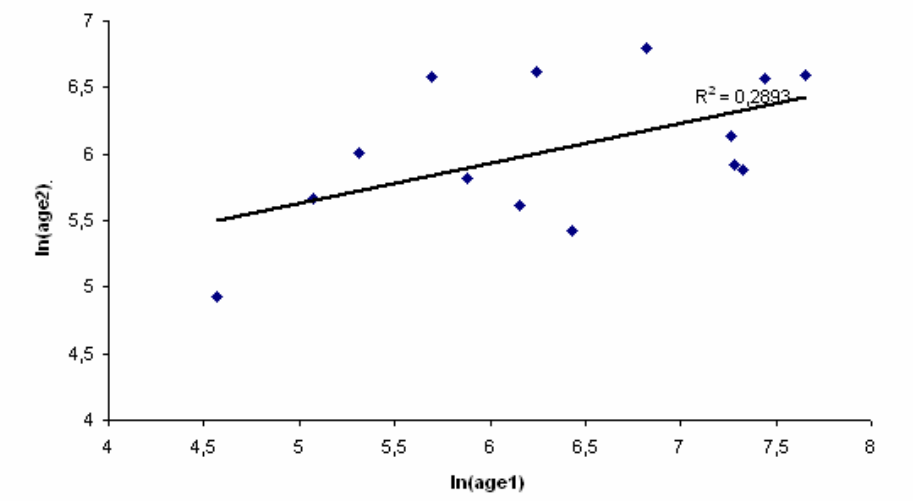

Fig. 18 relationship between age 1 and 2 of the same cohorts from the Paamiut trawl survey

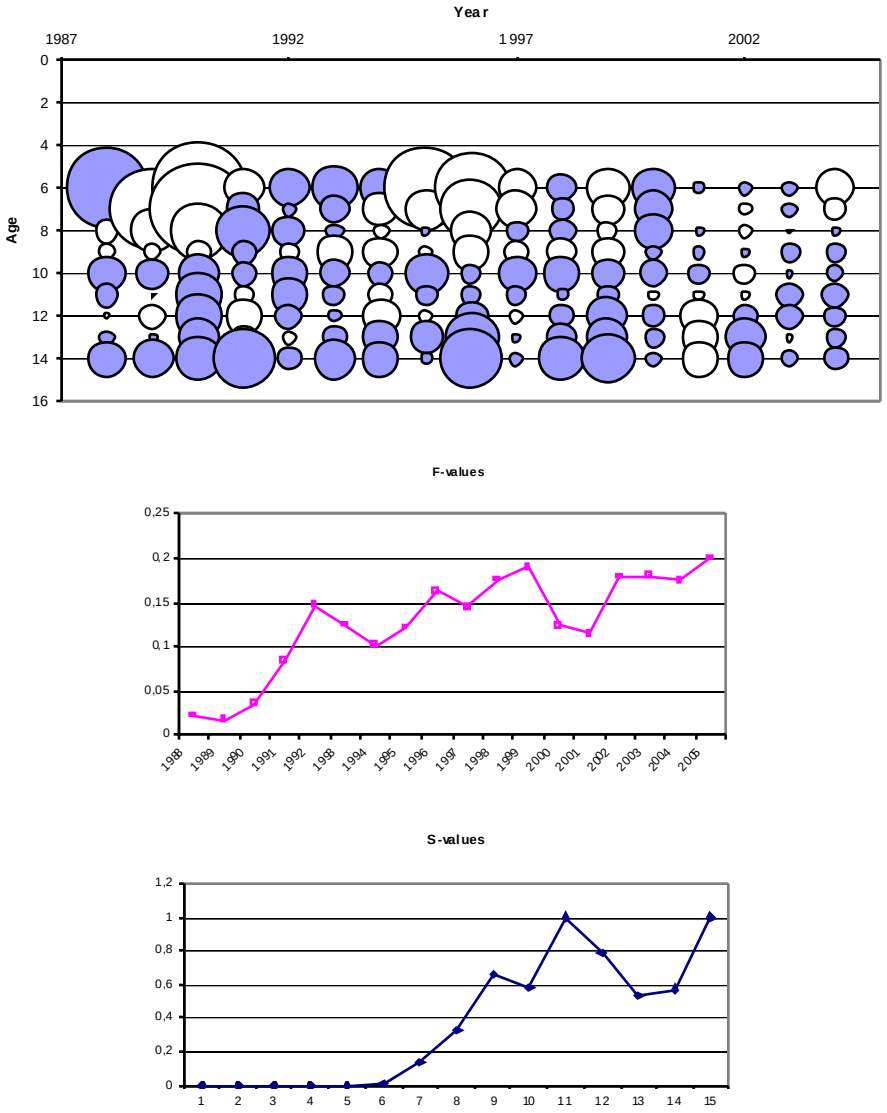

Fig. 19. Output from separable VPA; Given fixed selection pattern development in F (F-values) and (S-values) for ages 6-16 over the entire period are given residuals in the catch matrix (upper fig).

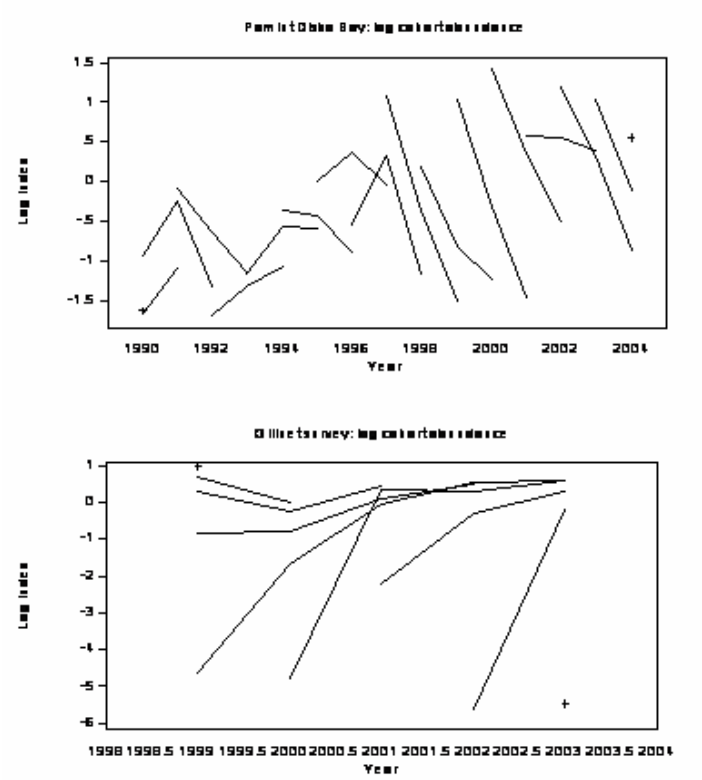

Fig. 20. Greenland halibut Log index values from the Pamiut Disko Bay survey (ages 1-3+) and the Gillnet survey (ages 2-6).

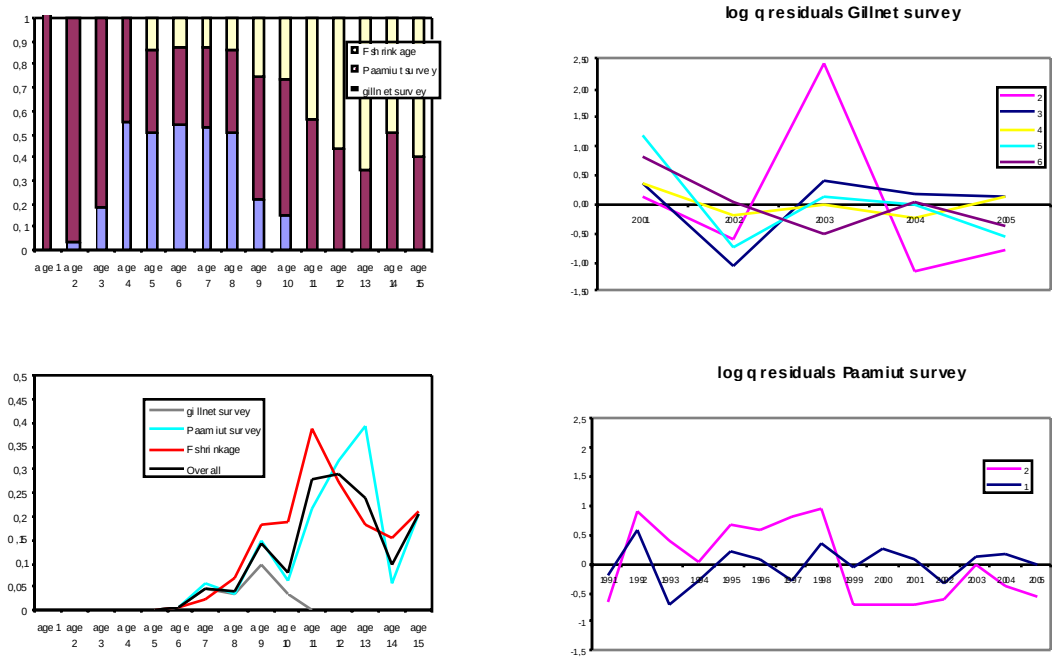

Fig. 21. XSA diagnostics; log q residuals (upper two), index weighting (middle section) and F estimates (lower section) by index for two options of shrinkage (0.5 and 2.0).

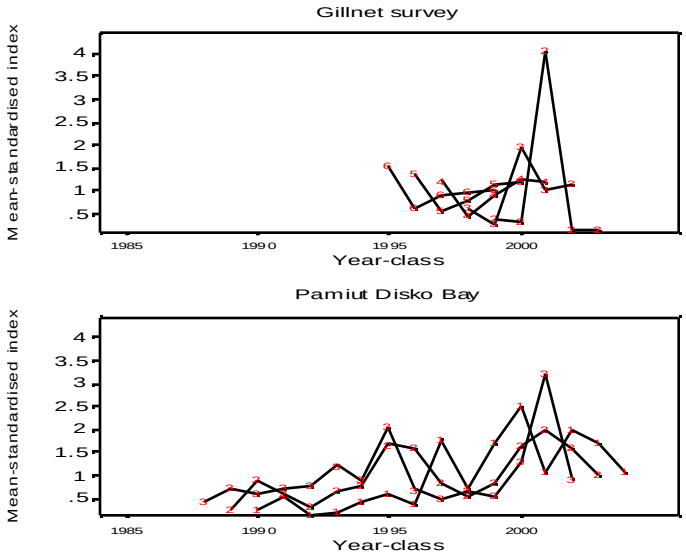

Fig 22. Greenland halibut in 1A. Disko bay. Mean standardised indices from Gillnet survey (upper) and Pamiut Disko Bay recruit survey (lower) by year-class.

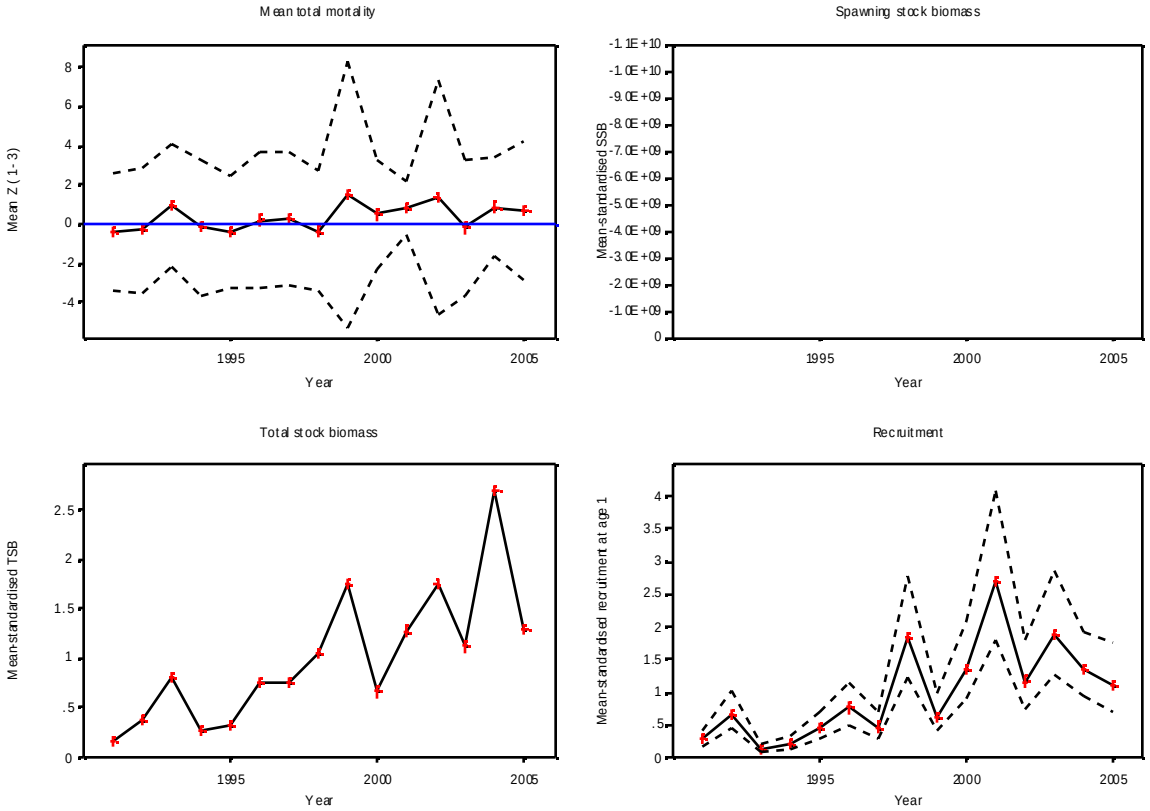

Fig. 23. Greenland halibut in 1A. Disko bay. SURBA run based on Pamiut Disko Bay survey.

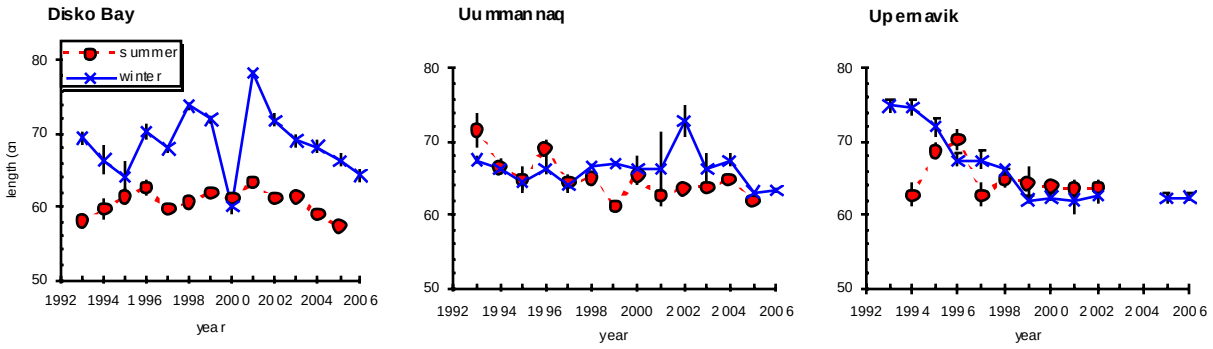

Fig. 24. Mean length of Greenland halibut in commercial longline catches from Ilulissat, Uummannaq and Upernavik with 95% conf. Int.

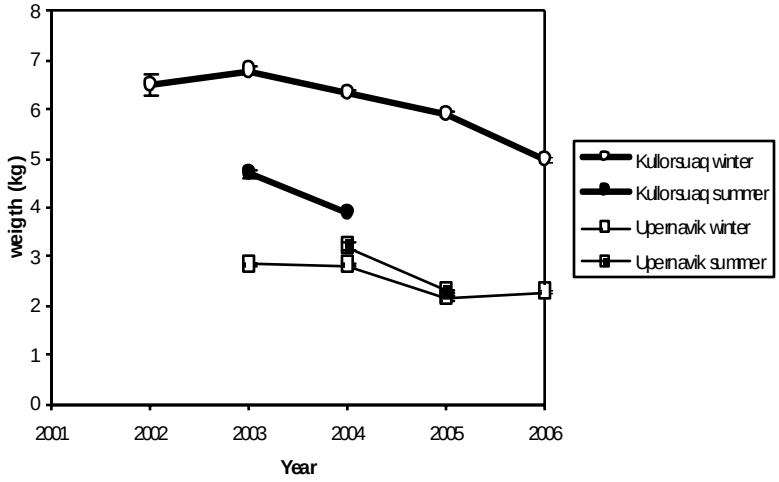

Fig. 25. Individual weights of Greenland halibut landed in Kullorsuaq and Upernavik

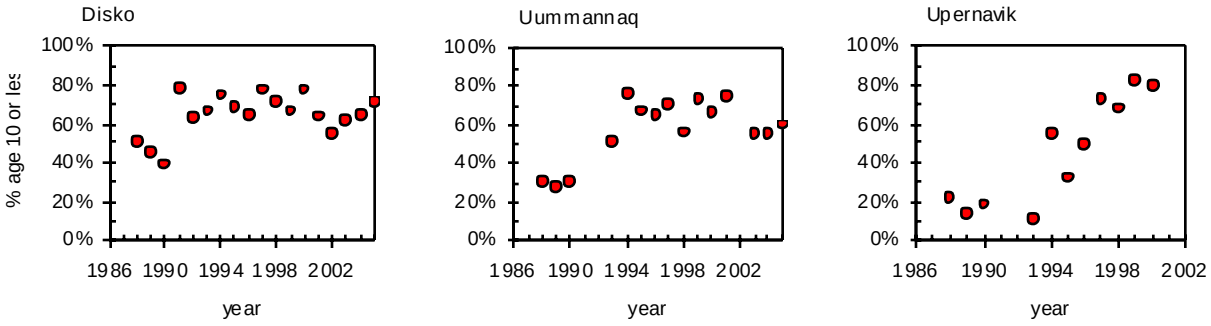

Fig. 26. The development in exploitation of the *age 10 and younger* expressed as percentages of those age groups in commercial landings by year.

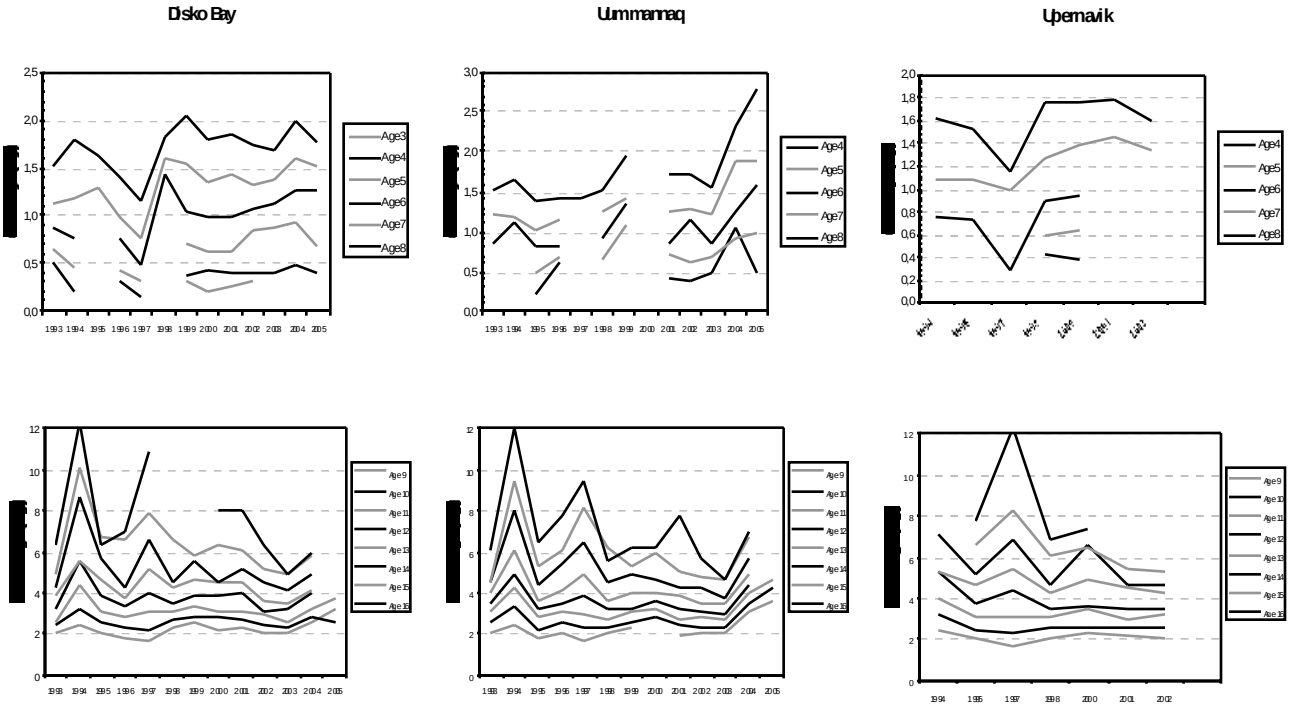

Fig. 27. Weight at age for the three areas Disko Bay, Uummannaq and Upernavik.

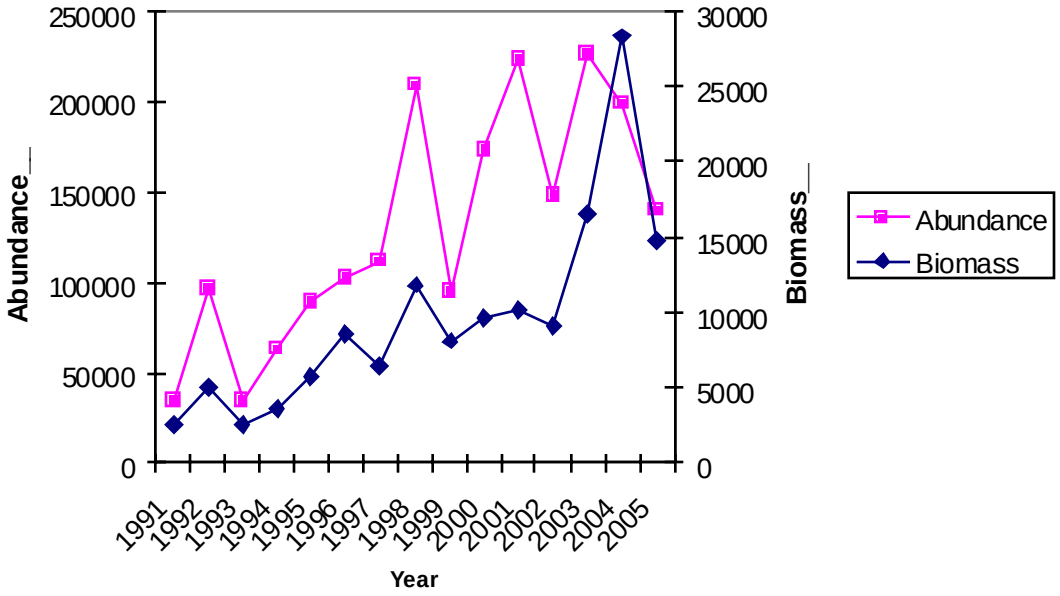

Fig. 28. Abundance ('1000) and Biomass (tons) indices of Greenland halibut from the Paamiut trawl survey in Disko Bay

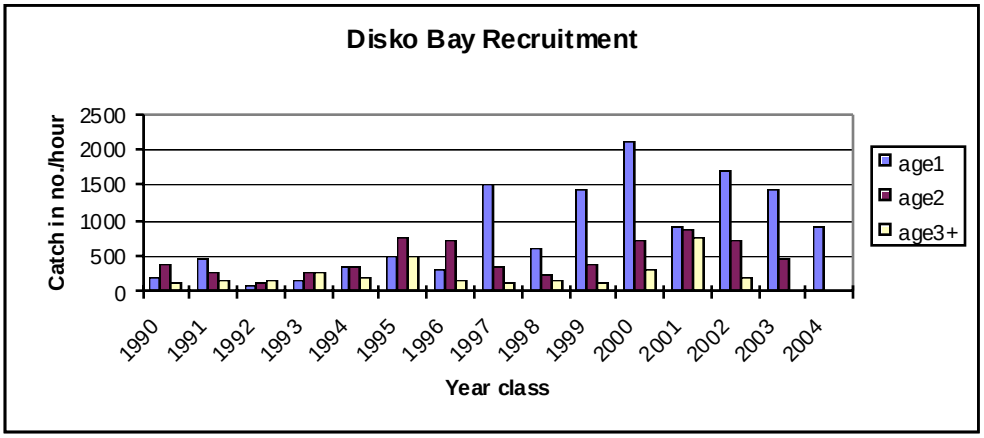

Fig. 29. Catch in number per hour of Greenland halibut at age 1, 2 and 3+ in the inshore Disko Bay. In 2005 a new survey trawl was introduced, but the 2005 catch figures have been adjusted to the old figures according to Sünksen *et al.* (SCR 06/xx) .